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16. Abstract

This document is the "As-Built System Software Document" for the Proportion Estimate Processor required as part B of the PIA Software System.

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FOR

PROPORTION ESTIMATE SOFTWARE SUBSYSTEM

Job Order 73-345

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CONTENTS

PROPORTION ESTIMATE PROCESSOR

1. SCOPE

This document contains the design of the Proportion Estimate Processor which was written to satisfy the software requirement of Part B of the P1A experiment. The purpose of the Proportion Estimate Processor is to evaluate four estimation techniques in order to get an improved estimate of the proportion of a scene that is planted in a selected crop. The four techniques to be evaluated have been provided by Techniques Development Section and are (1) Random Sampling, (2) Proportional Allocation - Relative Count Estimate, (3) Proportional Allocation - Bayesian Estimate, and (4) Sequential Bayesian Allocation. The user will be given two options for computation of the estimated mean square error. These will be referred to as the Cluster Calculation option and the Segment Calculation option.

2.0 APPLICABLE DOCUMENTS

2.1 Technical Memorandum:

The Multicategory Case of the Sequential Bayesian Pixel Selection and Estimation Procedure by M. D. Pore and T. B. Dennis.

2.2 LEC-13945

Clustering Algorithm Evaluation and the Development of a Replacement for Procedure 1 by R. K. Lennington and J. K. Johnson.

2.3 LEC-13940 ASA Proceedings 1979

Bayesian Techniques in Stratified Proportion Estimation by M. D. Pore.

2.4 LEC-12566 Earth Observation Division Version of
the Laboratory For Application of Remote Sensing System (EOD-LARSYS).

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3.0 SYSTEMS DESCRIPTION

3.1 HARDWARE DESCRIPTION

The software for the Proportion Estimate Processor will be operational on the IBM 3031 computer at Purdue.

3.2 SYSTEM DESCRIPTION

3.2.1 OVERVIEW

The Proportion Estimate Processor will read a control card file (4.2), the console, and two disk files created by the Pixel Selection and Display Processor. These two files (3.2.4.1) and (3.2.4.2) contain information about the number of clusters, size of each cluster, how the clusters are combined, and the labeled dots selected from the clusters. The processor will then calculate each of the four proportion estimates required for each crop label. The results will be output in a printer report (3.2.5.3) and two disk files (3.2.5.1) and (3.2.5.2). Appendix A contains a flow of this procedure. Fourteen software routines have been developed for this processor. Appendix A contains a flow of these routines and others used from the EOD LARSYS library routines.

3.2.2 COMMON BLOCK ESTIM

The common block ESTIM is used to communicate between the routines in the Proportion Estimate Processor. The parameter definitions are as follows:

NOCLS	Number of clusters in map file (max = 30).
ISUMCL (30)	Number of pixels in each cluster in the scene.
NTOT	Total number of pixels in scene = sum of ISUMCL values.
NDOTS	Number of dots in the input label file with labels belonging to the selected categories. (number of entries in arrays LABEL and ISORT - max = 500).
LABEL(9,500)	Information about dots - one entry per dot. (1,I) = Analyst Label

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(2,I) = Line number

(3,I) = Sample number

(4,I) = Original cluster number

(5,I) = Resulting cluster number
After combining clusters

(6,I) = Grid dot chosen from

(7,I) = Indicator for dots used in Random Sample Estimate
(= 0, not selected; ≠0 selected)

(8,I) = Indicator for dots used for Proportion Estimators
(= 0, not selected; ≠0, selected)

(9,I) = Indicator for dots used for Sequential Bayesian
Estimator (= 0, not selected, ≠0 selected).

NLAB(30) Count of dots in label array for each cluster.

ISORT(500) Sorted pointer table to entries in array LABEL - Sorted by ascending cluster number.

NPTS Number of dots user wishes to use in calculating estimates.

P(504,5) Proportion Estimate Results

P(1,I) = Random sampling results for label I.

P(2,I) = Proportional Allocation - Relative Count results for label I.

P(3,I) = Proportional Allocation - Bayesian results for label I.

P(J,I) = Sequential Bayesian results for label I (J=4 → KCNT)

THRES Threshold MSE value to be used in Sequential Bayesian (If zero use NPTS to determine estimate).

LCNT(5) Number of labels of interest in each category.

LAB(10,5) Array containing labels of interest for each category.

NOCAT Number of categories for evaluation maximum = 5.

ALPHA(5) Weighting factor for each category to be used in calculating mean square errors.

IOPT Options chosen

= 1 Use a fixed number of dots and use the cluster calculation technique.

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= 2 Use a fixed number of dots and use the segments calculation technique.

= 3 Use a number of dots determined by the threshold value in the Sequential Bayesian and the Cluster Calculation technique.

= 4 Use a number of dots determined by the threshold value in the Sequential Bayesian and the segment calculation techniques.

FMSE(504) = Mean Square Error

FSME(1) = MSE for Random Sampling

FSME(2) = MSE for Proportional Allocation Relative Count Estimate.

FSME(3) = MSE for Proportional Allocation Bayesian

FSME(J), J=4, KCNT = MSE for Sequential Bayesian

NCOUNT(504) Number of dots used for this calculation.

NCOUNT (1) = NPTS for Random Sampling.

NCOUNT (2) = NPTS for Proportional Allocation Relative Count Estimate.

NCOUNT (3) = NPTS for Proportional Allocation Bayesian.

NCOUNT (4) = Number of dots used for Sequential Bayesian calculation for 2 dots per active cluster.

NCOUNT (J), J=5, KCNT
(J=5 NCOUNT (5) = NCOUNT (4) +1
J=KCNT NCOUNT (J) = NPTS)

KCNT = Number of entries in NCOUNT, FMSE, and P arrays.

A(5) = Input values for constant A for each category - used in Bayesian calculation - required input for more than 2 categories.

3.2.3 PROGRAM DOCUMENTATION

3.2.3.1 PRPREST

Purpose

This is the driver routine for the Proportion Estimate Processor.

Linkages

PRPEST calls SETEST, RANDOM, PROPOR, and BAYES.

Interfaces

Interface is accomplished through common block ESTIM and subroutine calling arguments.

Inputs

Outputs

Storage Requirements

Description

The PRPEST program coordinates the logical steps in calculating the proportion estimate. It calls SETEST to read in the control cards and data files. It calls RANDOM to calculate the Random Sampling Proportion Estimate. It calls BAYES to calculate the Sequential Bayesian Allocation Proportion Estimate. It calls PROPOR to calculate both the Relative Count Estimate and the Bayesian Estimate for Proportional Allocation. It writes both the output Dot File and Results File and writes an EXEC file for passing filetype names back to the controlling EXEC file.

Flow Chart

Reference listing.

Listing

See Appendix B.1.

3.2.3.2 SETEST

Purpose

The purpose of the SETEST subroutine is to read the control cards and the two disk files (3.2.4.1) and (3.2.4.2) and start to build the common block ESTIM.

Linkages

SETEST is called by PRPEST and it calls the EODLARSYS subroutines NXTCHR, NUMBER, and FLTNUM.

Interfaces

SETEST interfaces with other routines by use of calling arguments and the common block ESTIM. It also uses the common block GLOBAL as a system standard interface.

Inputs

Calling sequence: CALL SETEST (IERR, ISEG, ITYPE, IXCNT, IXLAB, ICLCNT, ICLS)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IERR	1	OUT	Error indicator for errors in set up processing. = 0 no error = 1 error encountered
ISEG	1	OUT	Segment number for which Estimate is performed.
ITYPE	1	OUT	Type of dots used NXXY. N = R = reformatted N = G = ground truth N = I = integrated XX = analyst initials Y = version number
IXCNT	1	OUT	Count of labels to be ignored by processor range 1 to 3.
IXLAB	3	OUT	Labels to be ignored (the label X will always be ignored.)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
ICLCNT	1	OUT	Count of number of original input clusters that have been combined into other clusters.
ICLS	30	OUT	Cluster numbers that have been combined into other clusters.

The SETEST reads the control cards documented in section 4.2.

The SETEST read the two disk files documented in section 3.2.4.1 and 3.2.4.2. SETEST reads the console for the type of dots used.

Outputs

Report of input cards summary and error messages.

Storage Requirements

Description

The SETEST routine reads the control cards and the two input data files. It sets up the reread buffer and reads the keyword and data from the cards checking for errors and printing error messages as applicable. The subroutine then reads the cluster information data file filling in NOCLS and ISUMCL, & NTOT in ESTIM. It then checks for combined clusters and reworks ISUMCL if necessary. If two clusters are combined, the remaining cluster's ISUMCL entry will be the sum of the entries for the two combined cluster, and the eliminated cluster ISUMCL entry will be zero. Next the labelled dot data file will be read into the array label. If a label is blank, X, or matches a label input on the IGNORE card, or does not match an input label, then that dot will be ignored. The number of dots accepted for the label array will become NDOTS. Next the ISORT array will be built to contain printers to the dots in the label array by ascending cluster number order. The array IRES will be checked for combined clusters so that the pointers can be grouped to include cluster numbers for combined clusters.

While building the ISORT array the NLAB array of count of dots for each cluster remaining after combining will be built. The remaining clusters will be referred to as active clusters.

Flow Chart

Reference listing.

Listing

See Appendix B.2.

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3.2.3.3 BAYES

Purpose

The purpose of the Bayes subroutine is to calculate the Sequential Bayesian Allocation Proportion Estimate.

Linkages

BAYES is called by PRPEST and calls the random number generator subroutine RANDU and the subroutines FMSES, FMSEC, DMSES, and DMSEC.

Interfaces

BAYES interfaces with other routines by use of calling arguments and the common block ESTIM.

Inputs

Calling sequence: CALL BAYES (IPICK, IX, NI, IXI)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IPICK	500	IN/OUT	Work array to be used for picking random pointers into ISORT array which then point to entries in the LABEL array.
IX	1	IN/OUT	Seed value for subroutine RANDU changed after each call to RANDU.
NI	30	IN/OUT	Work array to contain counts of dots to be chosen from each active cluster.
IXI	30,5	IN/OUT	Work array to contain count of dots chosen in each cluster which have a label of interest for each category.

Output

Printer report of mean square error and proportion estimate values as points are picked. The report will also specify which cluster each additional dot is picked from.

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Storage Requirements

Description

The subroutine BAYES first randomly picks two dots in each active cluster. If there are only two categories of interest, then the subroutine will recalculate the values for the constants A used in the calculations by calculating a PINIT with the formula $PINIT(I) = -\sum_{J=1}^{NOCLS} (ISUMCL(J)/NOT)*$ $(IXI(J,I)+A(I)+1)/(NI(J)+ASUM + NOCAT)$

where $ASUM = \sum_{I=1}^{NOCAT} A(I)$

If PINIT(1) greater than .5

$$A(1) = 0,\ A(2) = \left[\frac{1 - PINIT(1)}{PINIT(1)}\right]^{-1}$$

If PINIT(1) less than .5

$$A(1) = \left[\frac{PINIT(1)}{1 - PINIT(1)}\right]^{-1},\ A(2) = 0$$

When more than two categories are involved, the user must have input the A(I) to use. Now the subroutine enters a processing loop to do the following:

1. Calculate the mean square error by calling FMSES or FMSEC depending on the calculation option chose.

2. Calculate the proportion estimate as:

   $$P(N,I) = \sum_{J=1}^{NOCLS} \frac{ISUMCL(J)}{NTOT} * \frac{(IXI(J,I) + A(I) + 1}{NI(J)+ASUM + NOCAT}$$

   for each category I.

3. Check that all necessary dots have been picked either by fixed number of dots or by MSE threshold reached. If all dots have been picked, return to PRPREST.

4. If more dots are needed calculate the ΔMSE value for each cluster by calling either DMSES or DMSEC depending on the calculation option chosen.

5. Determine which cluster to pick the next dot from by deciding which cluster has the largest ΔMSE value.

6. Pick a dot from the required cluster recalculate IXI and NI and return to point 1 in the loop.

Flow Chart

Reference listing.

Listing

See Appendix B.3.

3.2.3.4 RANDOM

Purpose

The purpose of the RANDOM subroutine is to compute the Random Sample Proportion Estimate.

Linkages

RANDOM is called by PRPEST and it calls the random number generator subroutine RANDU.

Interfaces

RANDOM interfaces with other routines by use of calling arguments and the common block ESTIM.

Inputs

Calling sequence: CALL RANDOM (IPICK,IX)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IPICK	500	IN/OUT	Work array to be used for picking random pointers into LABEL array.
IX	1	IN/OUT	Seed value for subroutine RANDU changed for each call to RANDU.

Outputs

Report of results of calculation for Random Sampling Proportion Estimate.

Storage Requirement

Description

The subroutine RANDOM calls the subroutine RANDU to generate random numbers. RANDOM scales them to a dot number entry in LABEL and verifies that each dot is only picked one time. The RANDOM counts the number of chosen dots (NPTS)

with a label I of interest (XLAB) and calculates the proportion estimate P(1,I) where P(1,I) = XLAB/NPTS for category I. Then the mean square error is calculated as

$$FMSE(1) = \sum_{I=1}^{NOCAT} ALPHA(I)*(P(1,I)*(1-P(1,I))/(NPTS-1)$$

Flow Chart

Reference listing.

Listing

See Appendix B.4.

3.2.3.5 PROPOR

Purpose

The purpose of the PROPOR subroutine is to calculate the Proportional Allocation - Relative Count Estimate and the Proportional Allocation Bayesian Estimate.

Linkages

PROPOR is called by PRPEST and calls the subroutines RANDU, FMSEC, and FMSES.

Interfaces

PROPOR interfaces with other routines by use of calling arguments and the common block ESTIM.

Inputs

Calling Sequence: CALL PROPOR(IPICK,IX,NI,IXI)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IPICK	500	IN/OUT	Work array to be used for picking random pointers into ISORT array which then points to entries in the LABEL array.
IX	1	IN/OUT	Such value for subroutine RANDU - changed for each call to RANDU.
NI	30	IN/OUT	Work array to contain count of dots to be chosen from each active cluster.
IXI	30,5	IN/OUT	Work array to contain count of dots chosen in each cluster which have a label of interest for each category.

Outputs

Report of results of calculations for Proportional Allocation Relative Count Estimate and for Proportional Allocation Bayesian Estimate.

Storage Requirements

Description

PROPOR first calculates the number of dots to pick from each active cluster. It uses the formula NI(J) = NPTS * ISUMCL (J)/NTOT where these variables are defined in section 3.2.2. Next the sum of NI(J) is checked to be sure it equals NPTS. If not, when the NI values are adjusted up or down by one starting with the largest NI value until $\sum_{J=1}^{NOCLS}$ NI(J) = NPTS. Next NI dots are chosen for each cluster J; they are chosen randomly and checked for no duplication. The labels of interest are counted in array IXI (J,I). Next the Proportional Allocation Relative Count Estimate and its mean square error are claculated by the following formulas:

$$P(2,I) = \sum_{J=1}^{NOCLS} \left(\frac{ISUMCL\ (J)}{NTOT}\right) * \left(\frac{IXI(J,I)}{NI(J)}\right)$$

and

$$FMSE(2) = \sum_{I=1}^{NOCAT} ALPHA(1)* \left(\frac{P(2,I) * (1-P(2,I))}{NPTS-1}\right)$$

Then for the two category case calculate values for A as

for P(2,1) less than .5

$$A(1) = \frac{P(2,1)^{-1}}{1 - P(2,1)^{-1}}, \quad A(2) = 0$$

for P(2,1) greater than .5

$$A(1) = 0, \quad A(2) = \left[\frac{1-P(2,1)}{P(2,1)}\right]^{-1}$$

Use the user input A values for more than two categories. Using the A values, calculate the Proportional Allocation Bayesian Estimate

$$P(3,I) = \sum_{J=1}^{NOCLS} \left(\frac{ISUMCL(J)}{NTOT}\right) * \left(\frac{IXI(J,I) + A(I) +1}{NI(J) + ASUM+NOCAT}\right)$$

where ASUM = $\sum_{I=1}^{NOCAT}$ A(I). Finally calculate the Bayesian mean square error by calling either FMSES or FMSEC according to the calculation option chosen.

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Flow Chart

Reference listing.

Listing

See Appendix B.5.

3.2.3.6 RANDU

Purpose

The subroutine RANDU will generate random numbers for use by the Proportion Estimator routines.

Linkages

RANDU is called by RANDOM, PROPOR, and BAYES.

Interface

RANDU interfaces with other routines by use of calling arguments.

Inputs

Calling Sequence: CALL RANDU(IX,IY,YFL)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IX	1	IN	Seed value for generating random number.
IY	1	OUT	Integer value to be used for IX on next call to RANDU.
YFL	1	OUT	Random number between 0 and 1 generated by RANDU.

Storage Requirements

Description

RANDU takes the seed value IX and multiplies it by 65539. Then it converts to a positive integer if necessary. Finally it scales the integer to a real number between 0 and 1. A suggested start value for the IX seed value is 187521429 but another nine digit integer can be used.

Flow Chart

Reference listing.

Listing

See Appendix B.6.

3.2.3.7 FMSES

Purpose

The subroutine FMSES will calculate the Means Square Error for the segment calculation option for the Bayesian estimates.

Linkages

FMSES is called by PROPOR and BAYES and it calls the function subroutines THETA, BIAS, and VAR.

Interfaces

FMSES interfaces with other routines through calling arguments.

Inputs

Calling Sequence: CALL FMSES (FMSE, ALPHA, IXI, NI, A, ASUM, NOCAT, NOCLS, ISUMCL, RTOT)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
FMSE	1	OUT	Mean Square Error calculation result.
ALPHA	5	IN	Weighting factor for each category of interest.
IXI	30,5	IN	Count of dots chosen for each category from each cluster.
NI	30	IN	Count of dots chosen from each cluster.
A	5	IN	Constant A for use in MSE equation one value per category.
ASUM	1	IN	Sum of A values.
NOCAT	1	IN	Number of categories of interest.
NOCLS	1	IN	Number of clusters in segment.
ISUMCL	30	IN	Count of pixels in each active cluster in segment.

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PARAMETER	DIMENSION	IN/OUT	DEFINITION
RTOT	1	IN	Total number of pixels in segment = sum of ISUMCL values.

Output

Results are returned in calling argument.

Storage Requirements

Description

This subroutine will calculate the mean square error according to the equation

$$FMSE = \sum_{I=1}^{NOCAT} ALPHA\ (I) * CMSE(I)$$

where:

$$CMSE(I) = V(I)+B(I)**2$$

$$V(I) = \sum_{J=1}^{NOCLS} \left[\left(\frac{ISUMCL(J)}{RTOT} **2\right)\right] * VAR(J)$$

and

$$B(I) = \sum_{J=1}^{NOCLS} \left(\frac{ISMUCL(J)}{RTOT}\right) * BIAS(J)$$

It uses the function subroutines THETA, VAR, and BIAS to get the value THETA and the values for VAR(J) and BIAS(J) used in the equations above.

Flow Chart

Reference listing.

Listing

See Appendix B.7.

3.2.3.8 FMSEC

Purpose

The subroutine FMSEC will calculate the Mean Square Error for the Cluster Calculation option for the Bayesian Estimators.

Linkages

FMSEC is called by PROPOR and BAYES and it calls the function subroutines THETA and RMSE.

Interfaces

FMSEC interfaces with the other routines through callimg arguments.

Inputs

Calling Sequence: CALL FMSEC (FMSE, ALPHA, IXI, NI, A, ASUM, NOCAT, NOCLS, ISUMCL, RTOT)

PARAMETER	DIMENSION	IN/OUT	DEFINITIONS
FMSE	1	OUT	Mean Square Error calculation result.
ALPHA	5	IN	Weighting factor for each category of interest.
IXI	30,5	IN	Count of dots chosen for each category from each cluster.
NI	30	IN	Count of dots chosen for each cluster.
A	5	IN	Constant A for use in MSE equation one value per category.
ASUM	1	IN	Sum of the A values.
NOCAT	1	IN	Number of categories of interest.
NOCLS	1	IN	Number of clusters in segment.
ISUMCL	30	IN	Count of pixels in each cluster in segment.

PARAMETER	DIMENSION	IN/OUT	DEFINITION
RTOT	1	IN	Total number of pixels in segment = sum of ISUMCL values.

Outputs

Results are retained in calling argument.

Storage Requirements

Description

This subroutine will calculate the mean square error according to the equation $FMSE \sum_{I=1}^{NOCAT} ALPHA(I) * CMSE(I)$

where

$$CMSE(I) = \sum_{J=1}^{NOCLS} \left(\left[\frac{ISUMCL(J)}{RTOT} \right] **2 \right) *RMSE(J)$$

The subroutine was the function subroutine RMSE to calculate the value for RMSE(J) in the equation above. It use the subroutine THETA to calculate the value for THETA to input to RMSE.

Flow Chart

Reference listing.

Listing

See Appendix B.8.

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3.2.3.9 DMSES

Purpose

The purpose of DMSES is to calculate the value of DMSE for each cluster as requested. When the segment calculation option is chosen for the Sequential Bayesian Allocation.

Linkages

DMSES is called by BAYES and calls the function subroutines THETA, VAR, and BIAS.

Interfaces

DMSES interfaces with other routines through calling arguments.

Inputs

Calling Sequence: CALL DMSES (IFRST, ILST, ISUMCL, IXI, NI, ASUM, NOCAT, A, ALPHA, RTOT, DMSE)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IFRST	1	IN	First cluster to calculate ΔMSE value for.
ILST	1	IN	Last cluster to calculate ΔMSE value for.
ISUMCL	30	IN	Count of pixels in each clusters in segment.
IXI	30,5	IN	Count of dots chose for each category from each cluster.
NI	30	IN	Count of dots chosen for each cluster.
ASUM	1	IN	Sum of A values.
NOCAT	1	IN	Number of categories of interest.
A	5	IN	Constant A for use in ΔMSE calculations 1 per category.

PARAMETER	DIMENSION	IN/OUT	DEFINITION
ALPHA	5	IN	Weighting factor for each category of interest.
RTOT	1	IN	Total number of pixels in segment = sum of ISUMCL values.
DMSE	30	OUT	DMSE value calculated for each cluster requested.

Outputs

The results are returned by the calling argument.

Storage Requirements

Description

This subroutine will calculate a ΔMSE value for each cluster from IFRST to ILST according to the following equation:

$$\text{DMSE(J)} = \sum_{\text{I=1}}^{\text{NOCAT}} \text{ALPHA(I) * CMSE(J,I)}$$

where

CMSE(J,I) = RMSE1 - ((1-T1) * RMSE2) - T1*RMSE3

RMSE 1 = MSE (THETA(NI(J), IXI(J,I)))

RMSE2 = MSE (THETA(NI(J)+1, IXI(J,I)))

RMSE3 = MSE (THETA(NI(J)+1, IXI(J,I)+1))

T1 = THETA (NI(J), IXI(J,I))

MSE = V + B**2

$$\text{V} = \left(\frac{\text{ISUMCL(J)}}{\text{RTOT}} \text{ **2}\right) \text{ * VAR(J)}$$

$$\text{B} = \frac{\text{ISUMCL(J)}}{\text{RTOT}} \text{ * BIAS(J)}$$

DMSES uses the function subroutines THETA, VAR, and BIAS(J), and THETA(N,X) used above.

Flow Chart

Reference listing.

Listing

See Appendix B.9.

3.2.3.10 DMSEC

Purpose

The purpose of DMSEC is to calculate the value of ΔMSE for each cluster as requested when the cluster calculation option is chosen for the Sequential Bayesian Allocation.

Linkages

DMSEC is called by BAYES and calls the function subroutines THETA and RMSE.

Interface

DMSEC interfaces with other routines through calling arguments.

Inputs

Calling Sequence: CALL DMSEC(IFRST, ILIST, ISUMCL, IXI, NI, ASUM, NOCAT, A, ALPHA, RTOT, DMSE)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IFRST	1	IN	First cluster to calculate ΔMSE value for.
ILST	1	IN	Last cluster to calculate ΔMSE value for.
ISUMCL	30	IN	Count of pixels in each cluster for segment.
IXI	30,5	IN	Count of dots chosen for each category from each cluster.
NI	30	IN	Count of dots chosen for each cluster.
ASUM	1	IN	Sum of A values.
NOCAT	1	IN	Number of categories of interest.
A	5	IN	Constant A for use in ΔMSE calculations - 1 per cluster.
ALPHA	5	IN	Weightine factor for each category of interest.

PARAMETER	DIMENSTION	IN/OUT	DEFINITION
RTOT	1	IN	Total number of pixels in segment = sum of ISUMCL values.
DMSE	30	OUT	ΔMSE values calculated for each cluster requested.

Outputs

The results are returned by the calling argument.

Storage Requirements

Description

This subroutine will calculate a ΔMSE value for each cluster from IFRST to ILST according to the following equation:

$$\text{DMSE(J)} = \sum_{I=1}^{NOCAT} \text{ALPHA(I) * CMSE(J,I)}$$

where

$$\text{CMSE(J,I)} = \left(\left[\frac{\text{ISUMCL(J)}}{\text{RTOT}} \quad **2\right)\right] * \text{(RMSE1 - (1-T1)* RMSE2 - T1*RMSE3)}$$

RMSE1 = RMSE (THETA(NI(J),IXI(J,I)))

RMSE2 = RMSE (THETA(NI(J)+1, IXI(J,I)))

RMSE3 = RMSE (THETA(NI(J)+1,IXI(J,I)+1))

TI = THETA(NI(J),IXI(J,I))

DMSEC use the function subroutines THETA and RMSE to calculate the values above.

Flow Chart

Reference listing.

Listing

See Appendix B.10.

3.2.3.11 THETA

Purpose

The purpose of the function subroutine THETA is to calculate the value of THETA to be used for computation of mean square errors and ΔMSE in the Bayesian Estimation Segment Calculation option.

Linkages

THETA is called by subroutines FMSES, FMSEC, DMSES, and DMSEC.

Interface

THETA interfaces with other routines through calling arguments.

Inputs

Calling Sequence: THETA(IXI,NI,A,ASUM,NOCAT)

PARAMETER	DIMENSION	IN/OUT	DEFINITION
IXI	1	IN	Count of number of dots chosen from NI dots with label of interest.
NI	1	IN	Count of total number of dots chosen for this cluster.
A	1	IN	Input constant A for this cateogry.
ASUM	1	IN	Input constant which is sum of A for all.
NOCAT	1	IN	Number of categories of interest.

Outputs

The value of THETA is returned to the calling routine.

Storage Requirements

Description

The function subroutine THETA will calculate the value for THETA according to the following equation:

$$THETA = \frac{IXI+A+1}{NI+ASUM+NOCAT}$$

Flow Chart

Reference listing.

Listing

See Appendix B.11.

30

3.2.3.12 BIAS

Purpose

The purpose of the function subroutine BIAS is to calculate the value of the bias for use in calculations of mean square error and DMSE for the Bayesian Estimators Segment Calculation option.

Linkages

BIAS is called by FMSES and DMSES.

Interfaces

BIAS interfaces with other routines through calling arguments.

Inputs

Calling Sequence: BIAS(THETA,NI,A,ASUM,NOCAT)

PARAMETER	DIMENSION	IN/OUT	DESCRIPTION
THETA	1	IN	Value for THETA calculated by routine THETA.
NI	1	IN	Count of total number of dots chosen for this cluster.
A	1	IN	Input constant for this category.
ASUM	1	IN	Sum of A values used for all categories.
NOCAT	1	IN	Number of categories of interest.

Outputs

The value of BIAS is returned to the calling subroutine.

Storage Requirements

Description

The function subroutine BIAS will calculate the value of the bias with the following equation:

$$BIAS = \frac{A+1 - THETA * (ASUM+NOCAT)}{NI+ASUM+NOCAT}$$

Flow Chart

Reference listing.

Listing

See Appendix B.12.

3.2.3.13 VAR

Purpose

The purpose of the function subroutine VAR is to calculate a value for variance for use in calculations of mean square error and ΔMSE for the Bayesian Estimators Segment Calculation option.

Linkages

VAR is called by FMSES and DMSES.

Interfaces

VAR interfaces with other routines through calling argument.

Inputs

Calling Sequence: VAR(THETA,NI,A,ASUM,NOCAT)

PARAMETER	DIMENSION	IN/OUT	DESCRIPTION
THETA	1	IN	Value for THETA calculated by routine THETA.
NI	1	IN	Count of total number of dots chosen for this cluster.
A	1	IN	Input constant for this category.
ASUM	1	IN	Sum of A values used for all categories.
NOCAT	1	IN	Number of categories of interest.

Output

The value of VAR is returned to the calling subroutine.

Storage Requirements

Description

The function subroutine VAR will calculate the value of the variance with the following equation:

$$VAR = \frac{NI*THETA*(1-THETA)}{(NI+ASUM+NOCAT)^2}$$

Flow Chart

Reference listing.

Listing

See Appendix B.13.

34

3.2.3.14 RMSE

Purpose

The purpose of the function subroutine RMSE is to calculate the Mean Square Error for the Sequential Bayesian Cluster Option.

Linkages

RMSE is called by FMSEC and DMSEC.

Interfaces

RMSE interfaces with other routines through calling arguments.

Inputs

Calling Sequence: RMSE(THETA,IXI,NI,A,ASUM,NOCAT)

PARAMETER	DIMENSION	IN/OUT	DESCRIPTION
THETA	1	IN	Value for THETA calculated by routine THETA.
IXI	1	IN	Count of set of NI dots in category of interest.
NI	1	IN	Count of total number of dots chosen for this cluster.
A	1	IN	Input constant for this category.
ASUM	1	IN	Sum of A values used for all categories.
NOCAT	1	IN	Number of categories of interest.

Outputs

The value for RMSE is returned to the calling routine.

Storage Requirements

Description

The function subroutine RMSE will calculate the value of the mean square error according to the following equation:

$$\text{RMSE} = \frac{\text{NI*THETA*(1-THETA)} + \text{(A+1-THETA* (ASUM+NOCAT))}^2}{\text{(NI+ASUM+NOCAT)}^2}$$

Flow Chart

Reference listing.

Listing

See Appendix B.14.

3.2.4 INPUT FILE FORMATS

3.2.4.1 Label File

The label file is a card image file containing a header card, one data card per dot labeled, an *END card, and some grid information cards. Only the HEADER, DATA, and *END cards are of interest to the processor and their formats follow. The filename of this file will be SEGM PlANXXY where SEGM = Segment Number N=R,G or I XX = Analyst Initials and Y = version number.

HEADER CARD

COLUMN	FORMAT	CONTENTS
1-4	I4	Number of Data Cards
5-30	26A1	'Pixels selected for SEGM'
31-35	I4	Segment Number

DATA CARD

COLUMN	FORMAT	CONTENTS
1-4	1A4	Analyst Label
5-8	1I4	Line Number
9-12	1I4	Sample Number
13-16	1I4	Cluster Number
17-20	1I4	Grid Number

*END CARD

COLUMN	FORMAT	CONTENTS
1-4	1A4	*END

3.2.4.2 Cluster Information File

The cluster information file is a card image file. The filename of this file is SEGM PROC2 where SEGM = Segment number.

CARD 1

COLUMN	FORMAT	CONTENTS
1-4	I5	Number of cluster in file

CARD 2

COLUMN	FORMAT	CONTENTS
1-60	15A5	Number of pixels in clusters 1-15.

CARD 3

COLUMN	FORMAT	CONTENTS
1-60	15A5	Number of pixels in clusers 16-30

CARD 4

COLUMN	FORMAT	CONTENTS
1-60	15A5	Resulting cluster number after combining for clusters 1-15.

CARD 5

COLUMN	FORMAT	CONTENTS
1-60	15A5	Resulting cluster number after combining for cluster 16-30.

3.2.5 OUTPUT FILE FORMATS

3.2.5.1 Output Dot File

The output Dot File is a card image file containing a header card and one card per labeled dot used by the Proportion Estimate Processor. The filename for this file is SEGM DAANXXY where AA = user options FC, FS, MC, or MS and NXXY = the NXXY from the Label File (3.2.4.1)

HEADER CARD

COLUMN	FORMAT	CONTENTS
1-4	1A4	Segment Number
5	1X	Blank
6	1A1	'D'
7-8	1A2	Processing options used 'FC' for fixed cluster option 'FS' for fixed segment option 'MC' for MSE cluster option 'MS' for MSE segment option
9-12	1A4	ITYPE - NXXY N = type of dots used R, G, or I XX = analyst initials Y = version number
13	1X	blank
14-16	I3	Number of dots used = NPTS
17	1Y	Blank
18-19	I2	Number of categories = NOCAT
20	1X	Blank
21,28, 35,42,49	1A1	Category label name

COLUMN	FORMAT	CONTENTS
22,29,36, 43,50	1A1	'_'
23-26, 30-33, 37-40, 44-47, 51-54	4A1	Category labels grouped into category of interest label
27,34, 41,48, 55	1X	Blank
56-58	3A1	Labels to ignore
59	1X	Blank
60-61	I2	Number of clusters combined into other cluster
62	1X	Blank
63,-64, 66-67, 69-70, 72-73, 75-76	I2	Cluster numbers combined into other cluster
65.68,71. 74,77	1X	Blank

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DATA CARD

COLUMN	FORMAT	CONTENTS
I-4	1A4	Analyst Label
5-8	1I4	Line Number
9-12	1I4	Sample Number
13-16	1I4	Original cluster number
17-20	1I4	Resulting Cluster number after combining
21-24	1I4	Grid number
25-28	1I4	Indicator for dot used in Random Sample Estimate. = 0 not selected; #0, selected
29-32	1I4	Indicator for dot used in Proportion Estimates = 0 not selected; #0, selected
33-36	1I4	Indicator for dot used in Bayesian Estimate = 0 not selected; #0, selected

3.2.5.2 Results File

The Results file is a card image file containing one header card and several data cards. The first data card will contain the Random Sampling Technique results. The second data card will contain the Proportional Allocation - Relative Count results. The third data card will contain the Proportional Allocation - Bayesian results. The remaining data cards will contain the Sequential Bayesian results. The fourth data card will contain the results obtained after picking two dots per cluster, the fifth will contain the results after adding one dot, etc, until either the Threshold MSE value is reached or the fixed number of dots have been chosen. The name of this file will be SEGM RAANXXY where AANXXY matches the ones for the output dot file (3.2.5.1). The card formats follow.

Header:

The header for this file is the same as the header for the output dot file except that column 6 will contain an R for results instead of the D for dots.

Data:

COLUMN	FORMAT	CONTENTS
1-3	I3	Number of dots used to compute this estimate.
4-11	F8.4	MSE value
12-19	F8.4	Estimate for category 1
20-27	F8.4	Estimate for category 2
28-35	F8.4	Estimate for category 3
36-43	F8.4	Estimate for category 4
44-51	F8.4	Estimate for category 5

3.2.5.3 Output Printer Report

The output printer report will be in two parts. Part 1 will be a summary of the input control cards and error messages or warning messages as required. Part 2 will contain the results of the run in the following order:

(1) Sequential Allocation Bayesian Estimate, (2) Random Sampling Estimate, (3) Proportional Allocation - Relative Count Estimate, and (4) Proportional Allocation Bayesian Estimate. See Appendix A for example report.

4.0 Users Guide

4.1 EXEC FILE

The user will access the Proportion Estimate Processor by use of the PRP exec (Appendix B.15).

To run the processor for a given segment and label file the user will enter

```
PRP 1234 P1ANXXY
  Where 1234 = segment number
      P1ANXXY = Input Label File filetype
            N = Dot set used R,G, or I
           XX = Analyst Initials
            Y = Version number
```

The following files will be expected on the users A disk.

```
1234 P1ANXXY = Input Label File (section 3.2.4.1)
1234 PROC2   = Cluster Information File (section 3.2.4.2)
PRP CC       = Control Card File (section 4.2)
```

Upon completion of the run the user should find a report output to the HOUSTON printer and two output disk files on the A disk:

```
1234 DAANXXY = Output Dot File (section 3.2.5.1)
1234 RAANXXY = Output Results File (section 3.2.5.2)
      where AA = User Options Chosen:
                 FC,FS,MC, or MS
```

4.2 CONTROL CARDS

The control cards will contain a keyword in columns 1-10 and data starting after column 11.

One of the following two cards is required:

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Keyword	Default	Type	Data
NPTS	none	Integer	Number of dtos to use for calculation of estimates - if this card is chosen, the user is chosing the fixed dot procedure option and the Sequential Bayesian will add dots until this number is reached and then stop.
THRES	none	Real	Threshold MSE value for the Sequential Bayesian - if this card is chosen, the user has chosen the MSE option and the Sequential Bayesian will add dcts until the MSE value drops below this threshold value - when that point is reached the number of dots (NPTS) to use for the remaining techniques will be fixed at the number of dots used for the Sequential Bayesian.

The following Cards are Required

Keyword	Default	Type	Data
ALPHA	none	Real	Weighting value for categories to be used in calculating MSE values - one value per category.
LABEL	none	Character	Labels of categories to be used for estimate calculations. The data will be in the form C=A,BB;N;S This says that these are three categories of interest: C,N, and S. The category C is made of dots labelled C,A, and BB. Two character labels are allowed and each category (a maximum of 5) can be made of up to 10 labels.

Keyword	Default	Type	Data
*END	none	Character	No data on this card the keyword signals the end of the control cards for this run.

The following card is required for more than two categories to evaluate.

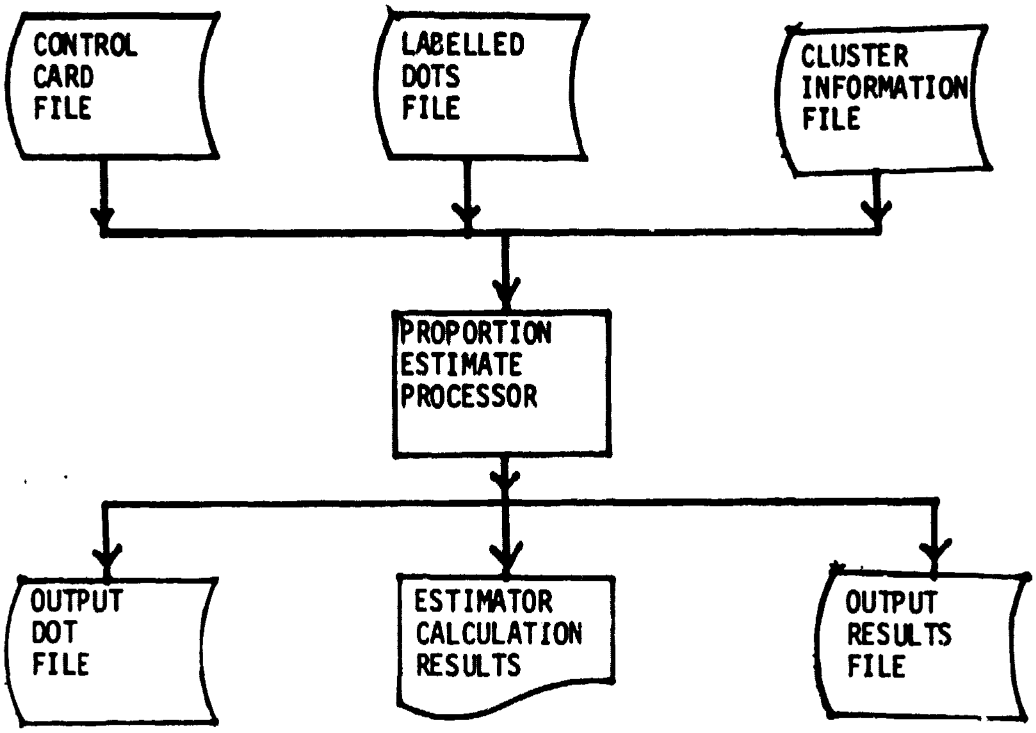
Keyword	Default	Type	Data
A	for 2 cateogry	Real	The constants A for use in Bayesian Technique computations - there should by one value per category see sections 3.2.3.1 through 3.2.3.14 for the A usage in equations

The following cards are optional

Keyword	Default	Type	Data
OPTION	C	Character	Calculation technique option. C = Cluster Option S = Segment Option
IGNORE	none	Character	Labels to ignore in the label file - the label X will always be ignored - the user may choose two additional labels to ignore.
COMMENT	none	Character	Any comment to be used in report heading.
HED1	none	Character	Header line 1 for report.
HED2	none	Character	Header line 2 for report.
DATE	none	Character	Date for report.

APPENDIX A
PIA SYSTEM FLOWCHARTS

4-7


CONTROL CARD FILE
LABELLED DOTS FILE
CLUSTER INFORMATION FILE
PROPORTION ESTIMATE PROCESSOR
OUTPUT DOT FILE
ESTIMATOR CALCULATION RESULTS
OUTPUT RESULTS FILE

- PRPEST
  - SETEST
    - NXTCHR
    - NUMBER
    - FILNUM
  - BAYES
    - RANDU
    - FMSES
      - THETA
      - BIAS
      - VAR
    - FMSEC
      - THETA
      - RMSE
    - DMSES
      - THETA
      - BIAS
      - VAR
    - DMSEC
      - THETA
      - RMSE
  - RANDOM
    - RANDU
  - PROPOR
    - RANDU
    - FMSES
      - THETA
      - BIAS
      - VAR
    - FMSEC
      - THETA
      - RMSE

```
                                        LYNDON B. JOHNSON SPACE CENTER
                                               HOUSTON, TEXAS
                                        PROPORTION ESTIMATOR

INPUT SUMMARY

     NPTS        75
     ALPH        1.0,0.0
     LABF        S*B,O,V,D
     OPTI
     *END

THE FOLLOWING PARAMETERS HAVE BEEN CHOSEN FOR SEGMENT 1556 AND FILE LISTRA12

NUMBER OF DOTS TO BE USED =    75
NUMBER OF CATEGORIES TO EVALUATE =     2
SEGMENT CALCULATIONS OPTION CHOSEN FOR BAYESIAN
THE FOLLOWING LABEL(S) WILL BE EVALUATED AND THE GIVEN ALPHA WILL BE APPLIED
     ALPHA=    1.0000      S     B     O     V
     ALPHA=    0.0               D
THE FOLLOWING LABELS WILL BE IGNORED
     *
```

ORIGINAL PAGE IS
OF POOR QUALITY

LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

PROPORTION ESTIMATOR

SEGMENT NUMBER 1666
OUTPUT FILES: DESRAT2 AND DESRAT2

SEQUENTIAL BAYESIAN ALLOCATION RESULTS

			LABELS:	S	N
22 POINTS USED	MSE=	0.0041	ESTIMATES=	0.4169	0.5831
POINT FROM CLUSTER 6 SELECTED					
23 POINTS USED	MSE=	0.0038	ESTIMATES=	0.4308	0.5692
POINT FROM CLUSTER 6 SELECTED					
24 POINTS USED	MSE=	0.0035	ESTIMATES=	0.4402	0.5598
POINT FROM CLUSTER 6 SELECTED					
25 POINTS USED	MSE=	0.0032	ESTIMATES=	0.4469	0.5531
POINT FROM CLUSTER 6 SELECTED					
26 POINTS USED	MSE=	0.0030	ESTIMATES=	0.4520	0.5480
POINT FROM CLUSTER 6 SELECTED					
27 POINTS USED	MSE=	0.0028	ESTIMATES=	0.4559	0.5441
POINT FROM CLUSTER 6 SELECTED					
28 POINTS USED	MSE=	0.0026	ESTIMATES=	0.4591	0.5409
POINT FROM CLUSTER 6 SELECTED					
29 POINTS USED	MSE=	0.0025	ESTIMATES=	0.4617	0.5383
POINT FROM CLUSTER 6 SELECTED					
30 POINTS USED	MSE=	0.0024	ESTIMATES=	0.4638	0.5362
POINT FROM CLUSTER 6 SELECTED					
31 POINTS USED	MSE=	0.0023	ESTIMATES=	0.4657	0.5343
POINT FROM CLUSTER 6 SELECTED					
32 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4672	0.5328
POINT FROM CLUSTER 9 SELECTED					
33 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4621	0.5379
POINT FROM CLUSTER 9 SELECTED					
34 POINTS USED	MSE=	0.0027	ESTIMATES=	0.4827	0.5173
POINT FROM CLUSTER 6 SELECTED					
35 POINTS USED	MSE=	0.0027	ESTIMATES=	0.4840	0.5160
POINT FROM CLUSTER 6 SELECTED					
36 POINTS USED	MSE=	0.0026	ESTIMATES=	0.4852	0.5148
POINT FROM CLUSTER 4 SELECTED					
37 POINTS USED	MSE=	0.0026	ESTIMATES=	0.4896	0.5104
POINT FROM CLUSTER 9 SELECTED					
38 POINTS USED	MSE=	0.0024	ESTIMATES=	0.4837	0.5163
POINT FROM CLUSTER 4 SELECTED					
39 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4757	0.5243
POINT FROM CLUSTER 6 SELECTED					
40 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4767	0.5233
POINT FROM CLUSTER 9 SELECTED					
41 POINTS USED	MSE=	0.0021	ESTIMATES=	0.4723	0.5277
POINT FROM CLUSTER 6 SELECTED					
42 POINTS USED	MSE=	0.0021	ESTIMATES=	0.4732	0.5268
POINT FROM CLUSTER 9 SELECTED					
43 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4859	0.5141
POINT FROM CLUSTER 9 SELECTED					
44 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4815	0.5185
POINT FROM CLUSTER 6 SELECTED					
45 POINTS USED	MSE=	0.0021	ESTIMATES=	0.4824	0.5176
POINT FROM CLUSTER 9 SELECTED					
46 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4920	0.5080
POINT FROM CLUSTER 6 SELECTED					
47 POINTS USED	MSE=	0.0022	ESTIMATES=	0.4928	0.5072
POINT FROM CLUSTER 9 SELECTED					
48 POINTS USED	MSE=	0.0021	ESTIMATES=	0.4887	0.5113
POINT FROM CLUSTER 6 SELECTED					
49 POINTS USED	MSE=	0.0021	ESTIMATES=	0.4894	0.5106
POINT FROM CLUSTER 9 SELECTED					
50 POINTS USED	MSE=	0.0020	ESTIMATES=	0.4859	0.5141
POINT FROM CLUSTER 6 SELECTED					
51 POINTS USED	MSE=	0.0020	ESTIMATES=	0.4865	0.5135
POINT FROM CLUSTER 4 SELECTED					
52 POINTS USED	MSE=	0.0019	ESTIMATES=	0.4808	0.5192
POINT FROM CLUSTER 9 SELECTED					
53 POINTS USED	MSE=	0.0019	ESTIMATES=	0.4778	0.5222
POINT FROM CLUSTER 6 SELECTED					
54 POINTS USED	MSE=	0.0019	ESTIMATES=	0.4784	0.5216
POINT FROM CLUSTER 9 SELECTED					
55 POINTS USED	MSE=	0.0018	ESTIMATES=	0.4758	0.5242
POINT FROM CLUSTER 6 SELECTED					
56 POINTS USED	MSE=	0.0018	ESTIMATES=	0.4763	0.5237
POINT FROM CLUSTER [illegible] SELECTED					

```
 57  POINTS USED          MSE=   [illegible]       ESTIMATES=   [illegible]   [illegible]
POINT FROM CLUSTER    6  SELECTED
 58  POINTS USED          MSE=   0.00[illegible]   ESTIMATES=   0.4746   0.5254
POINT FROM CLUSTER    4  SELECTED
 59  POINTS USED          MSE=   0.0017   ESTIMATES=   0.4702   0.5298
POINT FROM CLUSTER    6  SELECTED
 60  POINTS USED          MSE=   0.0017   ESTIMATES=   0.4707   0.5293
POINT FROM CLUSTER    4  SELECTED
 61  POINTS USED          MSE=   0.0017   ESTIMATES=   0.4687   0.5313
POINT FROM CLUSTER    6  SELECTED
 62  POINTS USED          MSE=   0.0017   ESTIMATES=   0.4691   0.5309
POINT FROM CLUSTER    1  SELECTED
 63  POINTS USED          MSE=   0.0016   ESTIMATES=   0.4602   0.5398
POINT FROM CLUSTER    1  SELECTED
 64  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4543   0.5457
POINT FROM CLUSTER    1  SELECTED
 65  POINTS USED          MSE=   0.0016   ESTIMATES=   0.4650   0.5350
POINT FROM CLUSTER    1  SELECTED
 66  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4600   0.5400
POINT FROM CLUSTER    1  SELECTED
 67  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4677   0.5323
POINT FROM CLUSTER    1  SELECTED
 68  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4740   0.5260
POINT FROM CLUSTER    1  SELECTED
 69  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4791   0.5209
POINT FROM CLUSTER    1  SELECTED
 70  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4833   0.5167
POINT FROM CLUSTER    1  SELECTED
 71  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4869   0.5131
POINT FROM CLUSTER    1  SELECTED
 72  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4825   0.5175
POINT FROM CLUSTER    1  SELECTED
 73  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4786   0.5214
POINT FROM CLUSTER    9  SELECTED
 74  POINTS USED          MSE=   0.0015   ESTIMATES=   0.4768   0.5232
POINT FROM CLUSTER    3  SELECTED
 75  POINTS USED          MSE=   0.0014   ESTIMATES=   0.4734   0.5266

        RANDOM SAMPLING RESULTS

                                                LABELS:      S        N
 75  POINTS USED          MSE=   0.0033   ESTIMATES=   0.5867   0.4133

        PROPORTIONAL ALLOCATION RELATIVE COUNT RESULTS

                                                LABELS:      S        N
 75  POINTS USED          MSE=   0.0033   ESTIMATES=   0.5600   0.4400

        PROPORTIONAL ALLOCATION BAYESIAN RESULTS

                                                LABELS:      S        N
 75  POINTS USED          MSE=   0.0017   ESTIMATES=   0.5930   0.4070
```

APPENDIX B

PIA PROGRAM LISTINGS

```
C
C      PROGRAM PRPEST  PROPORTION ESTIMATOR DRIVER
C
        IMPLICIT INTEGER(A-Z)
        COMMON/ESTIM/NOCLS,ISUMCL(30),TOT,NOOTS,LABEL(9,500),
      1 NLAM(30),ISORT(500),NPTS,P(50,5),THRES,LCNT(5),LAM(10,5),
      2 NOCAT,ALPHA(5),IOPT,FMSE(500),NCOUNT(500),KCNT,A(5)
        REAL P,THRES,FMSE,ALPHA,A
        DIMENSION IPICK(500),II(30),IX(10,5)
        DIMENSION IXLAM(3),ICLS(30),IOPTA(4)
        DATA IOPTA/'FC  ','FS  ','MC  ','MS  '/
        DATA D/'D   '/,R/'R   '/
        IX=187521429
        CALL SETEST(IERR,ISEQ,ITYPE,IXCNT,IXLAM,ICLCNT,ICLS)
        IF(IERR.EQ.0)GO TO 100
        WRITE(6,1000)
 1000   FORMAT(///,1X,'ERROR ON INPUT EXECUTION DELETED')
        GO TO 900
 100    CONTINUE
        CALL BAYES(IPICK,IX,NI,IXI)
        CALL RANDOM(IPICK,IX)
        CALL PROPOR(IPICK,IX,NI,IXI)
C
C    WRITE INPUT OUT FILE ON LUN 20 AND OUTPUT REPORT FILE ON 25
C
        WRITE(20,2000)ISEQ,D,IOPTA(IOPT),ITYPE,NPTS,NOCAT,
      1 ((LAM(I,J),I=1,5),J=1,5),(IXLAM(I),I=1,3),ICLCNT,
      1 (ICLS(I),I=1,ICLCNT)
 2000    FORMAT(1A4,1A,1A1,1A2,1A4,1X,I3,1X,I2,1X,5(1A1,'-',4A1,1X),
      1 3A1,1X,I2,1X,5(I2,1X))
        WRITE(25,2000)ISEQ,R,IOPTA(IOPT),ITYPE,NPTS,NOCAT,
      1 ((LAM(I,J),I=1,5),J=1,5),(IXLAM(I),I=1,IXCNT),ICLCNT,
      1 (ICLS(I),I=1,ICLCNT)
        DO 200 I=1,NOOTS
        WRITE(20,1100)(LABEL(J,I),J=1,9)
 1100    FORMAT(1A4,8I4)
 200    CONTINUE
        DO 300 I=1,KCNT
        WRITE(25,2100)NCOUNT(I),FMSE(I),(P(I,J),J=1,NOCAT)
 2100   FORMAT(I3,6F8.4)
 300    CONTINUE
C
C      WRITE OUTPUT EXEC FOR PASSING FILE TYPES TO PRP  EXEC
C
        WRITE(22,2200)D,IOPTA(IOPT),ITYPE,R,IOPTA(IOPT),ITYPE
 2200   FORMAT('&STACK ',1A1,1A2,1A4,/,'&STACK ',1A1,1A2,1A4)
 900    CONTINUE
        END
```

```
      SUBROUTINE SETEST(IERR,ISEG,ITYPE,IXCNT,IXLAB,ICLCNT,ICLS)
C
C       THIS IS THE SETUP ROUTINE FOR THE PROPORTION ESTIMATOR
C       PROCESSOR.
C       CALL ARGUMENTS:
C             IERR OUTPUT  ERROR INDICATOR  = 1 MEANS ERROR FOUND
C       ISEG OUTPUT SEGMENT NUMBER PROCESSED
C       ITYPE OUTPUT TYPE OF UNITS USED
C        IXCNT OUTPUT COUNT OF LABELS TO BE IGNORED
C       IXLAB OUTPUT ARRAY OF LABELS TO IGNORE
C       ICLCNT OUTPUT COUNT OF NUMBER OF CLUSTERS COMBINED INTO OTHER
C             CLUSTERS
C      ICLS  OUTPUT ARRAY OF CLUSTER NUMBERS THAT HAVE BEEN COMBINED
C
      IMPLICIT INTEGER(A-Z)
      DIMENSION HED1(15),HED2(15),DATE(3),COMENT(15)
      DIMENSION INVEC(12),ACARD(20),CARD(62),TITLE(5)
      DIMENSION IOPTA(4),ARRAY(62),ARRAY2(62)
      DIMENSION EQUVEC(2),IWES(30),IXLAB(3),ICLS(30)
      REAL P,THRES,FMSE,ALPHA,A
      COMMON/ESTIM/NOCLS,ISUMCL(30),ITOT,UNITS,LABEL(9,500),
     1 NLAB(30),ISORT(500),NPTS,P(504,5),THRES,LCNT(5),LAB(10,5),
     2 NOCAT,ALPHA(5),IOPT,FMSE(504),NCOUNT(504),KCNT,A(5)
      COMMON/GLOBAL/HEAD(63),MAPTAP,DATAPE,SAVTAP,HMFILE,HMKEY,HISFIL,
     1 HISKEY,TRFORM,FRIPTR,FRKEY,MAPUNT,DUFILE,DRUDAD,DUMMUS,
     2 PAGSIZ,DATFIL,STAFIL,ASAV,ASAVEL,HISTUG,NHSTFI,SCTRUN,MAPFIL,
     3 DOTUNT,DOTFIL,NCHPAS,TRUSEL,MATREL,HISTFL,PCHUNT,
     4 CRDUNT,PRTUNT,RADIO
      LOGICAL*1 BLAB1(4),BLAB2(4)
      EQUIVALENCE (HED1(1),HEAD(4)),(DATE(1),HEAD(22)),
     1 (HED2(1),HEAD(30)),(COMENT(1),HEAD(48))
      EQUIVALENCE (BLAB1(1),ILAB1),(BLAB2(1),ILAB2)
      DATA INVEC/'COMM','HED1','HED2','DATE','A   ','OPTI','NPTS',
     1 'ALPH','THRE','LABE','IGNO','ERRO'/
      DATA IOPTA/'EC  ','ES  ','MC  ','MS  '/
      DATA TITLE/'PROP','ORTI','ON E','STIM','ATOR'/
      DATA EQUAL/'='/,BLANK/' '/,E/'E'/,COMMA/','/
      DATA EQUVEC/'=',X/'X',SEMI/';'/
      DATA S/'S'/,C/'C'/
      DO 5 I=1,5
      COMENT(10+I)=TITLE(I)
    5 CONTINUE
      A(1)=-.485
      A(2)=0.
      INDA=0
      IXLAB(1)=X
      IXLAB(2)=BLANK
      IXLAB(3)=BLANK
      IXCNT=1
      ZERO=0
      DO 6 I=1,5
      LCNT(I)=0
      ALPHA(I)=0.
    6 CONTINUE
      NOCAT=0
      THRES=1.
      IERR=0
      IOPT=1
      NPTS=0
      ICLCNT=0
      DO 7 I=1,5
      DO 7 IJ=1,10
      LAB(IJ,I)=BLANK
    7 CONTINUE
C
C     WRITE HEADER
C
      WRITE(6,HEAD)
      WRITE(6,2000)
 2000 FORMAT(//,1X,'INPUT SUMMARY',//)
C
C    SET UP REREAD BUFFER UNIT 30
C
       CALL REREAD(30,R0)
C
C    PUT NEXT CARD IN REREAD BUFFER
C
   10 READ(2,1000)(ACARD(I),I=1,20)
```

```
1000  FORMAT(20A4)
      WRITE(30,1000)(ACARD(I),I=1,20)
      REWIND 30
C
C     READ CONTROL CARD
C
      READ(30,1100)CODE,CARD
1100  FORMAT(A4,6X,62A1)
      REWIND 30
      COL=0
      WRITE(6,1200)CODE,CARD
1200  FORMAT(7X,A4,4X,62A1)
      DO 20 J=1,12
      IF(CODE.EQ.IVEC(J))GO TO (100,120,140,160,170,180,200,210,
     1 220,240,260,280),J
20    CONTINUE
      WRITE(6,1300)CODE,CARD
1300  FORMAT(1X,'INVALID CARD-- IGNORED',T5,A4,6X,62A1)
      IERR=1
      GO TO 10
C
C     COMMENT CARD
C
100    READ(30,1400)COMENT
1400   FORMAT(10X,15A4)
      REWIND 30
       GO TO 10
C
C      HED1 CARD
C
120    READ(30,1400)HED1
       REWIND 30
       GO TO 10
C
C     HED2 CARD
C
140    READ(30,1400)HED2
      REWIND 30
       GO TO 10
C
C      DATE CARD
C
160    READ(30,1500)DATE
1500   FORMAT(10X,3A4)
       REWIND 30
       GO TO 10
C
C     CONSTANT A CARD FOR BAYESIAN SAVE IN ARRAY2
C
170    DO 175 I=1,62
      ARRAY2(I)=CARD(I)
175    CONTINUE
      INDA=1
      GO TO 10
C
C     OPTION CARD C=CLUSTER CALCULATIONS OPTION =1
C                 S=SEGMENT CALCULATIONS OPTION =2
C
180   M=NXTCHR(CARD,COL)
      IF(M.EQ.S)IOPT=2
      IF(M.EQ.C)IOPT=1
      IF(M.EQ.S.OR.M.EQ.C)GO TO 10
      IERR=1
      WRITE(6,1600)
1600  FORMAT(17,'ERROR ON OPTION CARD')
      GO TO 10
C
C     NPTS CARD
C
200    M=NXTCHR(CARD,COL)
       IF(M.NE.BLANK)GO TO 205
202     IERR=1
       WRITE(6,1700)
1700   FORMAT(1X,'ERROR ON NPTS CARD')
       GO TO 10
205   COL=COL-1
      J=NUMBER(CARD,COL,NPTS,1)
      IF(NPTS.LE.0)GO TO 202
      GO TO 10
```

```
C
C     ALPHA CARD SAVE ARRAY TO PROCESS AFTER *END CARD
C
210     DO 215 I=1,62
        ARRAY(I)=CARD(I)
215    CONTINUE
       GO TO 10
C
C      THRESHOLD CARD
C
220     J=FLTNO (CARD,COL,THRES,1)
        GO TO 10
C
C     LABEL CARD ALLOW 2 CHARACTER LABELS
C
240    NOCAT=NOCAT+1
242     LCNT(NOCAT)=LCNT(NOCAT)+1
       ILAB1=BLANK
       ILAB2=BLANK
245    M=NXTCHR(CARD,COL)
       IF(M.EQ.BLANK)GO TO 250
       IF(M.EQ.COMMA)GO TO 250
       IF(M.EQ.SEMI)GO TO 255
       IF(M.EQ.EQUAL)GO TO 259
       ILAB1=M
       M=NXTCHR(CARD,COL)
       IF(M.EQ.COMMA)GO TO 250
       IF(M.EQ.SEMI)GO TO 255
       IF(M.EQ.EQUAL)GO TO 259
       ILAB2=M
        BLAB1(2)=BLAB2(1)
       GO TO 245
250    LAB(LCNT(NOCAT),NOCAT)=ILAB1
       GO TO 242
255    LAB(LCNT(NOCAT),NOCAT)=ILAB1
       IF(LCNT(NOCAT).GT.ZERO.AND.LCNT(NOCAT).LE.10)GO TO 240
257    WRITE(6,1800)
1800  FORMAT(1X,'ERROR ON LABEL CARD')
        IERR=1
       GO TO 10
259    LAB(LCNT(NOCAT),NOCAT)=ILAB1
       IF(LCNT(NOCAT).GT.ZERO.AND.LCNT(NOCAT).LE.10)GO TO 10
       GO TO 257
C
C     IGNORE CARD
C
260    IXCNT=IXCNT+1
       ILAB1=BLANK
       ILAB2=BLANK
265    M=NXTCHR(CARD,COL)
       IF(M.EQ.BLANK)GO TO 275
       IF(M.EQ.COMMA)GO TO 270
       ILAB1=M
       M=NXTCHR(CARD,COL)
       IF(M.EQ.COMMA)GO TO 270
       ILAB2=M
       BLAB1(2)=BLAB2(1)
       GO TO 265
270    IXLAB(IXCNT)=ILAB1
       GO TO 260
275    IXLAB(IXCNT)=ILAB1
       IF(IXCNT.GT.1.AND.IXCNT.LE.3)GO TO 10
       WRITE(6,1850)
1850   FORMAT(1X,'ERROR ON IGNORE LABEL CARD')
       IERR=1
       GO TO 10
C
C      *END CARD
C
280     CONTINUE
C
C     CHECK FOR EITHER NPTS OR THRESHOLD CARD
C
       IF(NPTS.EQ.0.AND.THRES.EQ.0)IERR=1
       IF(NPTS.EQ.0.AND.THRES.EQ.0)WRITE(6,2025)
2025     FORMAT(1X,'ERROR  MUST HAVE EITHER AN NPTS CARD OR A THRESHOLD
     1 CARD')
       IF(NPTS.NE.0)GO TO 279
       IF(IOPT.EQ.1)IOPT=3
```

```
      IF(IOPT.EQ.2)IOPT=4
C
C     NOW DECODE ARRAY FOR ALPHA VALUES AND A VALUES IF ANY
C
279   COL=0
      J=FLTNUM(ARRAY,COL,ALPHA,NOCAT)
      IF(INDA.EQ.0.AND.NOCAT.GT.2)GO TO 281
      IF(INDA.EQ.0)GO TO 282
      COL=0
      J=FLTNUM(ARRAY2,COL,A,NOCAT)
      GO TO 282
281   IERR=1
      WRITE(6,1860)
1860   FORMAT(1X,'ERROR -  NO A VALUES INPUT FOR BAYESIAN')
C
C     WRITE PARAMETER REPORT
C
282     READ(29,3150)ISEG
3150   FORMAT(33X,1A4)
      READ(7,3175)ITYPE
3175  FORMAT(1A4)
      WRITE(6,2100)ISEG,ITYPE
2100  FORMAT(///,1X,'THE FOLLOWING PARAMETERS HAVE BEEN CHOSEN FOR SEGM
     1ENT ',1A4,' AND FILE LIST',1A4)
      IF(NPTS.NE.0)WRITE(6,2200)NPTS
2200  FORMAT(//,1X,'NUMBER OF DOTS TO BE USED =',I5)
      IF(THRES.NE.0)WRITE(6,2300)THRES
2300   FORMAT(1X,'THRESHOLD MSE VALUE FOR BAYESIAN =',F10.4)
      WRITE(6,2250)NOCAT
2250  FORMAT(1X,'NUMBER OF CATEGORIES TO EVALUATE =',I5)
      IF(IOPT.EQ.1.OR.IOPT.EQ.3)WRITE(6,2260)
2260  FORMAT(1X,'CLUSTER CALCULATIONS OPTION CHOSEN FOR BAYESIAN')
      IF(IOPT.EQ.2.OR.IOPT.EQ.4)WRITE(6,2270)
2270  FORMAT(1X,'SEGMENT CALCULATIONS OPTION CHOSEN FOR BAYESIAN')
285    WRITE(6,2500)
2500   FORMAT(1X,'THE FOLLOWING LABEL(S) WILL BE EVALUATED AND THE GIVE
     1N ALPHA WILL BE APPLIED')
      DO 290 I=1,NOCAT
      K=LCNT(I)
       WRITE(6,2600)ALPHA(I),(LAB(J,I),J=1,K)
2600   FORMAT(5X,'ALPHA=',F10.4,5X,10(1A4,1X))
290    CONTINUE
      WRITE(6,2550)
2550  FORMAT(1X,'THE FOLLOWING LABELS WILL BE IGNORED')
      DO 295 I=1,IKCNT
      WRITE(6,2650)IKLAB(I)
2650   FORMAT(5X,1A4)
295   CONTINUE
      IF(INDA.EQ.0.AND.NOCAT.GT.2)GO TO 298
      IF(NOCAT.GT.2)WRITE(6,2660)(A(I),I=1,NOCAT)
2660   FORMAT(1X,'THE FOLLOWING VALUES WILL BE USED FOR A:',5X,5F10.4)
C
C
C
C     READ PASS FILE  FOR CLUSTER COUNTS AND COMBINED CLUSTERS
C
298    READ(24,3100)NOCLS
3100  FORMAT(15I5)
      READ(24,3100)(ISUMCL(I),I=1,15)
      READ(24,3100)(ISUMCL(I),I=16,30)
C
C     READ ARRAY CONTAINING RESULTS OF COMBINING
C     IF CLUSTER NOT COMBINED INTO ANOTHER CLUSTER  ITS INDEX
C     VALUE WILL EQUAL ITS CLUSTER NUMBER
C     EXAMPLE:  IREC(1)=1  MEANS CLUSTER 1 NOT COMBINED
C      IF CLUSTER HAS BEEN COMBINED INTO ANOTHER CLUSTER THEN
C      ITS VALUE WILL BE THE CLUSTER NUMBER IT HAS BEEN COMBINED
C      INTO  EXAMPLE:  IREC(2)=1 MEANS THAT CLUSTER 2 HAS BEEN
C      COMBINED INTO CLUSTER 1
C
      READ(24,3100)(IRES(I),I=1,15)
      READ(24,3100)(IRES(I),I=16,30)
      DO 300 I=1,NOCLS
      IF(IRES(I).EQ.I)GO TO 300
      ISUMCL(IRES(I))=ISUMCL(IRES(I))+ISUMCL(I)
      ISUMCL(I)=0
      ICLCNT=ICLCNT+1
      ICLS(ICLCNT)=I
300   CONTINUE
C
```

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```
C       CALCULATE NTOT TOTAL NUMBER OF POINTS IN SCENE
C
        NTOT=0
        DO 575 I=1,NOCLS
        NTOT=NTOT+ISUMCL(I)
575     CONTINUE
C
C       SET UP NLAB ARRAY TO ZERO
C
        DO 600 I=1,NOCLS
        NLAB(I)=0
600     CONTINUE
C
C       READ LABEL PASS FILE
C
        DO 650 J=1,501
625     READ(29,3000,END=675)(LABEL(I,J),I=1,4),LABEL(6,J)
3000    FORMAT(1A4,4I4)
        IF(LABEL(1,J).EQ.INVEC(12))GO TO 675
        IF(LABEL(1,J).EQ.BLANK)WRITE(6,3250)
3250       FORMAT(/,1X,'WARNING    BLANK LABEL ENCOUNTERED   IGNORED',/)
        IF(LABEL(1,J).EQ.BLANK)GO TO 625
        DO 630 K=1,ICNT
        IF(LABEL(1,J).EQ.IFLAB(K))GO TO 625
630     CONTINUE
C
C      CHECK TO BE SURE ALL LABELS ACCOUNTED FOR
C
        DO 640 K=1,NOCAT
        L=LCNT(K)
        DO 640 KK=1,L
        IF(LABEL(1,J).EQ.LAB(KK,K))GO TO 650
640     CONTINUE
        WRITE(6,3125)LABEL(1,J)
3125    FORMAT(1X,'LABEL ',1A4,' UNKNOWN   IGNORED')
        GO TO 625
650     CONTINUE
        IERR=1
        WRITE(6,4000)
4000     FORMAT(1X,'TOO MANY DOTS IN LABEL FILE MAX=500')
        RETURN
675     NDOTS=J-1
C
C       SET UP LABEL(5,I) FOR COMBINED CLUSTER RESULTING CLUSTER NUMBER
C
        DO 680I=1,NDOTS
        LABEL(5,I)=IRES(LABEL(4,I))
680     CONTINUE
C
C        BUILD ISORT ARRAY AND NLAB ARRAY
C
        K=1
        DO 700 I=1,NOCLS
        IF(ISUMCL(I).EQ.0)GO TO 700
        DO 710 J=1,NDOTS
        IF(LABEL(5,J).NE.I)GO TO 710
        ISORT(K)=J
        K=K+1
        NLAB(I)=NLAB(I)+1
710     CONTINUE
700     CONTINUE
        WRITE (6,HEAD)
        WRITE(6,4100)ISEG
4100    FORMAT(20X,'SEGMENT NUMBER ',1A4)
        WRITE(6,4150)IOPTA(IOPT),ITYPE,IOPTA(IOPT),ITYPE
4150       FORMAT(20X,'OUTPUT FILES:',' W',1A2,1A4,' AND D',1A2,1A4)
        RETURN
         END
```

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Appendix 8.3


```
      SUBROUTINE BAYES(IPICK,IX,NI,IXI)
C
C     SUBROUTINE BAYES WILL CALCULATE THE SEQUENTIAL BAYES
C     PROPORTION ESTIMATOR.
C     CALL ARGUMENTS:
C         IPICK   ARRAY TO BE USED FOR PICKING RANDOM POINTERS
C                 INTO LABEL ARRAY
C         IX      SEED VALUE FOR SUBROUTINE RANDU
C         NI      ARRAY FOR COUNTING NUMBER OF POINTS PICKED
C                 FROM LABEL ARRAY FOR EACH CLUSTER
C         IXI     ARRAY FOR COUNTING NUMBER OF LABELS OF INTEREST
C                 ON POINTS NI FOR EACH CLUSTER
C
      COMMON/ESTIM/NOCLS,ISUMCL(30),NTOT,NDOTS,LABEL(9,500),
     1 NLAB(30),ISORT(500),NPTS,P(504,5),THRES,LCNT(5),LAB(10,5),
     2 NOCAT,ALPHA(5),IOPT,EMSE(504),ICOUNT(504),KCNT,A(5)
      DIMENSION IPICK(500),NI(30),IXI(30,5),ISUM(30),DMSE(30)
      DIMENSION PINIT(5),IGNOR(30)
      PTOT=NTOT
      WRITE(6,2100)(LAB(1,I),I=1,5)
 2100 FORMAT(//,20X,'SEQUENTIAL BAYESIAN ALLOCATION RESULTS',//,
     1 65X,'LABELS',5X,5(A4,6X),/)
C
C     SET UP ARRAY NI FOR 2 POINTS IN EACH ACTIVE CLUSTER
C
      KCNT=3
      ICNT=0
      DO 10 I=1,NOCLS
      NI(I)=0
      IF(ISUMCL(I).NE.0)NI(I)=2
   10 CONTINUE
      DO 15 J=1,NOCAT
      DO 15 I=1,NOCLS
      IXI(I,J)=0
   15 CONTINUE
C
C     SUM COUNTS OF NUMBER OF ENTRIES IN ARRAY ISORT PRECEEDING
C     THE CLUSTER I ENTRIES
C
      DO 20 I=1,NOCLS
      ISUM(I)=0
      IF(I.EQ.1)GO TO 20
      ISUM(I)=ISUM(I-1)+NLAB(I-1)
   20 CONTINUE
C    NCNT IS POINTER INTO IPICK ARRAY AND COUNT OF
C         NUMBER OF POINTS PICKED FROM LABEL
      NCNT=0
C
C     SELECT 2 POINTS FROM LABEL  FOR EACH ACTIVE CLUSTER
C     AND COUNT LABELS OF INTEREST
C
      DO 70 I=1,NOCLS
      IF(NLAB(I).EQ.0)GO TO 70
      IF(NLAB(I).LT.2)GO TO 600
      MEM=NLAB(I)-1
      DO 70 J=1,2
      NCNT=NCNT+1
   30 CALL RANDU(IX,IY,YFL)
      IX=IY
      NUM=MEM*YFL+1.5
C
C     CHECK TO BE SURE NOT PICKING SAME POINT TWICE
C
      IF(J.EQ.1)NUM1=NUM
      IF(J.EQ.1)GO TO 50
      IF(NUM.EQ.NUM1)GO TO 30
   50 IPICK(NCNT)=NUM+ISUM(I)
      LABEL(9,ISORT(IPICK(NCNT)))=NCNT
      DO 60 K=1,NOCAT
      KK=LCNT(K)
      DO 60 L=1,KK
      IF(LABEL(1,ISORT(IPICK(NCNT))).EQ.LAB(L,K))IXI(I,K)=IXI(I,K)+1
   60 CONTINUE
   70 CONTINUE
C
C     CALCULATE PINIT AND A
C
      ASUM=0
      DO 75 I=1,NOCAT
```

```
      PINIT(I)=0
      ASUM=ASUM+A(I)
75    CONTINUE
      IF(NOCAT.GT.2)GO TO 103
      DO 100 J=1,NOCAT
      DO 100 I=1,NOCLS
      IF(NI(I).EQ.0)GO TO 100
      PINIT(J)=PINIT(J)+(ISUMCL(I)/RTOT)*(IXI(I,J)+A(J)+1)/(NI(I)+
     1 ASUM+NOCAT)
100   CONTINUE
      ASUM=0
      IF(PINIT(1).GT..5)GO TO 102
      A(1)=PINIT(1)/(1-PINIT(1))
      A(1)=A(1)-1
      A(2)=0
      ASUM=A(1)
      GO TO 103
C
C     PINIT GREATER THAN .5
C
102    A(1)=0
      A(2)=((1-PINIT(1))/PINIT(1))-1
       ASUM=A(2)
C
C  LOOP FOR CALCULATING ESTIMATOR BEGINS HERE
C
103   IFRST=1
      ILST=NOCLS
C
C    CALCULATE FMSE
C
105    KCNT=KCNT+1
      IF(IOPT.EQ.1.OR.IOPT.EQ.3)CALL FMSEC(FMSE(KCNT),ALPHA,IXI,NI,A,
     1 ASUM,NOCAT,NOCLS,ISUMCL,RTOT)
       IF(IOPT.EQ.2.OR.IOPT.EQ.4)CALL FMSES(FMSE(KCNT),ALPHA,IXI,NI,A,
     1 ASUM,NOCAT,NOCLS,ISUMCL,RTOT)
C
C    CALCULATE P(4) AND WRITE RESULTS
C
      DO 114 ICAT=1,NOCAT
      P(KCNT,ICAT)=0
114     CONTINUE
      DO 125 ICAT=1,NOCAT
      DO 120 I=1,NOCLS
      IF(ISUMCL(I).EQ.0)GO TO 120
      P(KCNT,ICAT)=P(KCNT,ICAT)+(ISUMCL(I)/RTOT)*(IXI(I,ICAT)+A(ICAT)+
     1 1)/(NI(I)+ASUM+NOCAT)
120    CONTINUE
125    CONTINUE
      NCOUNT(KCNT)=NCNT
      WRITE(6,2000)NCNT,FMSE(KCNT),(P(KCNT,ICAT),ICAT=1,NOCAT)
2000   FORMAT(10X,I5,2X,'POINTS USED',10X,'MSE=',F10.4,
     1  10X,'ESTIMATES=',5F10.4)
C
C    CHECK TO SEE IF CALCULATIONS COMPLETE
C
      IF(THRES.NE.0.AND.NCNT.GE.NDOTS)GO TO 950
      IF(THRES.EQ.0.AND.NCNT.GE.NPTS)GO TO 900
      IF(THRES.GE.FMSE(KCNT).AND.THRES.NE.0)GO TO 900
C
C     CALCULATE DMSE ARRAY VALUES
C     FIRST TIME THROUGH CALCULATE ONE FOR EACH CLUSTER
C     SUBSEQUENT TIMES CALCULATE ONLY DMSE FOR CHANGED CLUSTER
C
      IF(IOPT.EQ.1.OR.IOPT.EQ.3)CALL DMSEC(IFRST,ILST,ISUMCL,IXI,NI,
     1 ASUM,NOCAT,A,ALPHA,RTOT,DMSE)
      IF(IOPT.EQ.2.OR.IOPT.EQ.4)CALL DMSES(IFRST,ILST,ISUMCL,IXI,NI,
     1 ASUM,NOCAT,A,ALPHA,RTOT,DMSE)
C
C    DETERMINE CLUSTER FOR SELECTION OF NEXT PIXEL
C
201   DO 210 I=1,NOCLS
      IF(ICNT.EQ.0)GO TO 205
      DO 202 IJ=1,ICNT
      IF(I.EQ.IGROUP(IJ))GO TO 210
202   CONTINUE
205   DMAX=DMSE(I)
      IF(DMAX.NE.0)GO TO 220
210   CONTINUE
```

```
220     ICLST=1
        DO 230 I=1,NOCLS
        IF(ICNT.EQ.0)GO TO 222
        DO 225 J=1,ICNT
        IF(I.EQ.IGNOR(J))GO TO 230
225      CONTINUE
222     IF(DMSE(I).EQ.0)GO TO 230
        IF(DMSE(I).GT.DMAX)ICLST=I
        IF(DMSE(I).GT.DMAX)DMAX=DMSE(ICLST)
230     CONTINUE
        WRITE(6,2200)ICLST
2200    FORMAT(10X,'POINT FROM CLUSTER',I5,'  SELECTED')
C
C      SELECT PIXEL FROM CLUSTER ICLST AND COUNT LABEL OF INTEREST
C
        IF(NI(ICLST).EQ.NLAB(ICLST))GO TO 300
        NI(ICLST)=NI(ICLST)+1
        NCNT=NCNT+1
        MEM=NLAB(ICLST)-1
240     CALL RANDU(IX,IY,YFL)
        IX=IY
        NUM=MEM*YFL+1.5+ISUM(ICLST)
        LIM=NCNT-1
        DO 250 I=1,LIM
        IF(NUM.EQ.IPICK(I))GO TO 240
250     CONTINUE
        IPICK(NCNT)=NUM
        LABEL(9,ISORT(NUM))=NCNT
        DO 260 K=1,NOCAT
        KK=LCNT(K)
        DO 260 L=1,KK
        IF(LABEL(1,ISORT(IPICK(NCNT))).EQ.LAB(L,K))IXI(ICLST,K)=
     1 IXI(ICLST,K)+1
260     CONTINUE
        IFRST=ICLST
        ILST=ICLST
        GO TO 105
C
C      ERROR NEED ANOTHER POINT IN CLUSTER BUT NO MORE AVAILABLE
C
300     WRITE(6,1100)ICLST
1100    FORMAT(1X,'CLUSTER',I5,2X,'NEEDS MORE POINTS THAN AVAILABLE',
     1 10X,'CLUSTER IGNORED')
        ICNT=ICNT+1
        IGNOR(ICNT)=ICLST
        GO TO 201
C
C      ERROR GOT 2 POINTS IN EACH ACTIVE CLUSTER
C
600     WRITE(6,1000)
1000     FORMAT(1X,'ERROR IN SEQUENTIAL BAYESIAN PROCESSOR')
        WRITE(6,1200)I
1200    FORMAT(1X,'CLUSTER',I5,2X,'DOES NOT HAVE 2 POINTS',/,
     1 1X,'SEQUENTIAL BAYES ESTIMATE NOT CALCULATED')
        STOP
900     NPTS=NCNT
        RETURN
950      WRITE(6,1225)
1225     FORMAT(1X,'THRESHOLD TOO SMALL NEEDS MORE DOTS THAN IN FILE')
        STOP
        END
```

ORIGINAL PAGE IS
OF POOR QUALITY

Appendix B.4


```
      SUBROUTINE RANDOM (IPICK,IX)
C
C     THIS SUBROUTINE CALCULATES THE PROPORTION ESTIMATOR FOR THE
C     RANDOM SAMPLING TECHNIQUE
C
C     CALL ARGUMENTS ARE:
C        IPICK  ARRAY TO BE USED FOR PICKING RANDOM POINTERS INTO
C               LABEL ARRAY
C        IX     SEED VALUE FOR SUBROUTINE RANDU OUTPUT FROM
C               THIS ROUTINE
C
      COMMON/ESTIM/NOCLS,ISUMCL(30),NTOT,NDOTS,LABEL(9,500),
     1 NLAB(30),ISORT(500),NPTS,P(504,5),THRES,LCNT(5),LAB(10,5),
     2 NOCAT,ALPHA(5),IOPT,FMSE(504),NCOUNT(504),KCNT,A(5)
      DIMENSION IPICK(500)
      WRITE(6,1100)(LAB(I,1),I=1,5)
 1100 FORMAT(//,20X,'RANDOM SAMPLING RESULTS',//,
     1 65X,'LABELS',5X,5(1A4,6X),/)
      XLAB=0.
      FMSE(1)=0.
      MEM=NDOTS-1
C
C     FIND SET OF DOTS TO USE FOR CALCULATION
C
      DO 100 I=1,NPTS
   25 CALL RANDU(IX,IY,YFL)
      IX=IY
      NUM=MEM*YFL+1.5
C
C    CHECK TO BE SURE THIS NUMBER IS UNIQUE FOR THIS SET
C
      LL=I-1
      IF(LL.EQ.0)GO TO 75
      DO 50 IJ=1,LL
      IF(IPICK(IJ).EQ.NUM)GO TO 25
   50 CONTINUE
   75 IPICK(I)=NUM
      LABEL(7,ISORT(NUM))=1
  100 CONTINUE
C
C     COUNT DOTS WITH LABEL OF INTEREST
C
      ICAT=1
  150 DO 200 I=1,NPTS
      K=LCNT(ICAT)
      DO 200 J=1,K
      IF(LABEL(1,ISORT(IPICK(I))).EQ.LAB(J,ICAT))XLAB=XLAB+1
  200 CONTINUE
C
C     CALCULATE P(I)
C
      P(1,ICAT)=XLAB/NPTS
      NCOUNT(1)=NPTS
      FMSE(1)=FMSE(1)+ALPHA(ICAT)*(P(1,ICAT)*(1-P(1,ICAT)))/(NPTS-1)
      IF(ICAT.EQ.NOCAT)WRITE(6,1000)NPTS,FMSE(1),(P(1,I),I=1,NOCAT)
 1000 FORMAT(13X,I5,2X,'POINTS USED',10X,'MSE=',F10.4,10X,
     1 'ESTIMATES=',5F10.4)
      IF(ICAT.EQ.NOCAT)RETURN
      ICAT=ICAT+1
      XLAB=0
      GO TO 150
      END
```

```
      SUBROUTINE PROPOR(IPICK,IX,NI,IXI)
C
C       THIS SUBROUTINE WILL CALCULATE THE PROPORTION ALLOCATION
C        ESTIMATORS FOR THE PROPORTION ESTIMATOR PROCESSOR
C
C       CALL ARGUMENTS:
C            IPICK    ARRAY FOR USE IN PICKING RANDOM POINTS
C                       FROM ARRAY LABEL
C             IX      INPUT SEED VALUE FOR SUBROUTINE RANDU TO
C                       USE IN RANDOM SAMPLING CHOICES
C            NI       ARRAY FOR COUNTING THE NUMBER OF POINTS TO
C                       CHOSE FOR EACH CLUSTER FROM ARRAY LABEL
C            IXI      ARRAY FOR COUNTING THE NUMBER OF LABELS OF
C                       INTEREST FOR EACH POINT CHOSEN IN NI
C
      COMMON/ESTIM/NOCLS,ISUMCL(30),NTOT,NDOTS,LABEL(9,500),
     1 NLAB(30),ISORT(500),NPTS,P(500,5),TMEAS,LCAT(5),LAB(10,5),
     2 NOCAT,ALPHA(5),IOPT,FUSE(500),MCOUNT(500),KCNT,A(5)
      DIMENSION IPICK(500),IXI(30,5),NI(30),NV(30),AI(5)
C
C       CALCULATE THE VALUES FOR ARRAY NI
C
      RTOT=NTOT
      DO 10 I=1,NOCLS
      NI(I)=NPTS*(ISUMCL(I)/RTOT)+.5
 10   CONTINUE
C
C    BE SURE SUM OF NI EQUALS NPTS ADJUST IF NECESSARY
C
      N=0
      DO 20 I=1,NOCLS
      N=N+NI(I)
 20   CONTINUE
      IF(N.EQ.NPTS)GO TO 105
      LIM=NPTS-N
      IFAC=1
      IF(N.GT.NPTS)LIM=N-NPTS
      IF(N.GT.NPTS)IFAC=-1
C
C    FIND NI WITH LARGEST VALUE
C
      IMAX=1
      DO 30 I=1,NOCLS
      IF(NI(I).GT.NI(IMAX))IMAX=I
 30   CONTINUE
      NV(1)=IMAX
      IF(LIM.EQ.1)GO TO 55
      DO 50 I=2,LIM
      K=I-1
      NV(I)=1
      IF(NV(K).EQ.1)NV(I)=2
      DO 40 J=1,NOCLS
      IF(NI(J).LT.NI(NV(K)).AND.NI(J).GT.NI(NV(I)))NV(I)=J
      IF(NI(J).EQ.NI(NV(K)).AND.NI(J).GT.NI(NV(I)))GO TO 32
      GO TO 40
 32   DO 35 L=1,I
      IF(J.EQ.NV(L))GO TO 40
 35   CONTINUE
      NV(I)=J
 40   CONTINUE
 50   CONTINUE
 55   DO 60 I=1,LIM
      NI(NV(I))=NI(NV(I))+IFAC
 60   CONTINUE
C
C       SET UP TO PICK OUTS
C
 105  NCNT=1
      DO 150 I=1,NOCLS
      IF(NLAB(I).EQ.0)GO TO 150
      IF(NLAB(I).LT.NI(I))GO TO 500
      MEM=NLAB(I)-1
      ISUM=0
C
C       ISUM IS THE SUM OF THE NUMBER OF POINTS IN THE ARRAY ISORT
C            FOR THE CLUSTERS PRECEEDING THE CLUSTER WANTED
C
      DO 115 K=1,I
      ISUM=ISUM+NLAB(K)
```

```
115   CONTINUE
      ISUM=ISUM-NLAB(I)
C
C     DO LOOP TO PICK NI POINTS FOR CLUSTER I
C
      LIM=NI(I)
      DO 150 J=1,LIM
120   CALL RANDU(IX,IY,YFL)
      IX=IY
      NUM=MEM*YFL+1.5+ISUM
C
C     CHECK TO BE SURE THIS POINT HAS NOT ALREADY BEEN PICKED
C
      LL=NCNT-1
      IF(LL.EQ.0)GO TO 140
      DO 130 IJ=1,LL
       IF(IPICK(IJ).EQ.NUM)GO TO 120
130    CONTINUE
140   IPICK(NCNT)=NUM
      LABEL(2,ISORT(NUM))=NCNT
      NCNT=NCNT+1
150   CONTINUE
C
C     SET UP IXI ARRAY TO ZERO
C
155   DO 156 J=1,NOCAT
      DO 156 I=1,NOCLS
      IXI(I,J)=0
156   CONTINUE
C
C     NOW COUNT PIXELS WITH LABEL OF INTEREST
C
      ISTRT=1
      LIM=NI(1)
      DO 200 I=1,NOCLS
      IF(NI(I).EQ.0)GO TO 170
      DO 160 J=ISTRT,LIM
      DO 160 ICAT=1,NOCAT
      KK=LCNT(ICAT)
      DO 160 K=1,KK
      IF(LABEL(1,ISORT(IPICK(J))).EQ.LAB(K,ICAT))IXI(I,ICAT)
     1 =IXI(I,ICAT)+1
160   CONTINUE
170   ISTRT=1+LIM
      LIM=LIM+NI(I+1)
200   CONTINUE
C
C     CALCULATE P(2)  PROPORTION ALLOCATION RELATIVE COUNT ESTIMATE
C
      FMSE(2)=0
      DO 310 ICAT=1,NOCAT
      P(2,ICAT)=0.
      DO 300 I=1,NOCLS
      IF(NI(I).EQ.0)GO TO 300
      RNI=NI(I)
      P(2,ICAT)=P(2,ICAT)+(ISUMCL(I)/RTOT)*(IXI(I,ICAT)/RNI)
300   CONTINUE
      FMSE(2)=FMSE(2)+ALPHA(ICAT)*(P(2,ICAT)*(1-P(2,ICAT)))/(NPTS-1)
310    CONTINUE
      NCOUNT(2)=NPTS
C
C    CALCULATE P(3)  PROPORTIONAL ALLOCATION BAYESIAN ESTIMATOR
C
      ASUM=0
      IF(NOCAT.GT.2)GO TO 360
       IF(P(2,1).GT..5)GO TO 350
      AI(1)=P(2,1)/(1-P(2,1))
      AI(1)=AI(1)-1
      AI(2)=0
      ASUM=AI(1)
      P(3,1)=0
      P(3,2)=0
      GO TO 390
C
C     P(2,1) GREATER THAN .5
C
350    AI(1)=0
      AI(2)=((1-P(2,1))/P(2,1))-1
      ASUM=AI(2)
```

65

```
      P(3,1)=0
      P(3,2)=0
      GO TO 390
C
C     FOR NOCAT GT 2 USE INPUT A FOR AI VALUES
C
360   DO 370 ICAT=1,NOCAT
      AI(ICAT)=A(ICAT)
      ASUM=ASUM+AI(ICAT)
      P(3,ICAT)=0
370   CONTINUE
390   DO 400 ICAT=1,NOCAT
      DO 400 I=1,NOCLS
      IF(NI(I).EQ.0) GO TO 400
      P(3,ICAT)=P(3,ICAT)+(ISUMCL(I)/RTOT)*((IXI(I,ICAT)+AI(ICAT)+1)/
     1 (NI(I)+ASUM+NOCAT))
400   CONTINUE
      NCOUNT(3)=NPTS
C
C     CALCULATE FMSE
C
      IF(IOPT.EQ.1.OR.IOPT.EQ.3)CALL FMSEC(FMSE(3),ALPHA,IXI,NI,AI,
     1 ASUM,NOCAT,NOCLS,ISUMCL,RTOT)
      IF(IOPT.EQ.2.OR.IOPT.EQ.4)CALL FMSES(FMSE(3),ALPHA,IXI,NI,AI,
     1 ASUM,NOCAT,NOCLS,ISUMCL,RTOT)
      GO TO 900
C
C     ERROR REQUESTED TOO MANY POINTS FOR ONE CLUSTER
C
509   WRITE(6,1000)I,NI(I),NLAM(I)
1000  FORMAT(1X,'ERROR IN PROPORTIONAL ALLOCATION CALCULATIONS',
     1 /,1X,'FOR CLUSTER',I5,2X,I5,2X,'POINTS REQUIRED',
     2 I5,2X,'POINTS AVAILABLE',/,1X,
     3'PROPORTION ESTIMATES NOT CALCULATED')
      RETURN
C
C     WRITE OUTPUT FOR P(2), P(3)
C
900   WRITE(6,2000)(LAB(1,I),I=1,NOCAT)
2000  FORMAT(//,20X,'PROPORTIONAL ALLOCATION RELATIVE COUNT RESULTS',
     1 //,65X,'LABELS:',5X,5(1A4,6X),/)
      WRITE(6,2100)NPTS,FMSE(2),(P(2,I),I=1,NOCAT)
2100  FORMAT(10X,I5,2X,'POINTS USED',10X,'MSE=',F10.4,
     1 10X,'ESTIMATES=',5F10.4)
      WRITE(6,2200)(LAB(1,I),I=1,NOCAT)
2200  FORMAT(//,20X,'PROPORTIONAL ALLOCATION BAYESIAN RESULTS',
     1 //,65X,'LABELS:',5X,5(1A4,6X),/)
      WRITE(6,2100)NPTS,FMSE(3),(P(3,I),I=1,NOCAT)
      RETURN
      END
```

Appendix B.6


```
      SUBROUTINE RANDU(IX,IY,YFL)                                       RAN00010
C                                                                       RAN00020
C     THIS SUBROUTINE WILL GENERATE RANDOM NUMBERS                      RAN00030
C                                                                       RAN00040
      IY=IX*65539                                                       RAN00050
      IF(IY)5,6,6                                                       RAN00060
5     IY=IY+2147483647+1                                                RAN00070
6     YFL=IY                                                            RAN00080
      YFL=YFL*.4656613E-9                                               RAN00090
      RETURN                                                            RAN00100
      END                                                               RAN00110
```

FILE: FMSES   FORTRAN   A   PURDUE / LARS 3031


```
      SUBROUTINE FMSES(FMSE,ALPHA,IXI,NI,A,ASUM,NOCAT,NOCLS,ISUMCL,
     1 RTOT)
C
C     THIS SUBROUTINE WILL CALCULATE THE FINAL MSE VALUE FOR THE
C      SEQUENTIAL BAYESIAN SEGMENT OPTION
C
      DIMENSION A(5),ALPHA(5),NI(30),IXI(30,5),ISUMCL(30)
      FMSE=0
      DO 100 ICAT=1,NOCAT
      CMSE=0
      B=0
      V=0
      DO 110 I=1,NOCLS
      IF(ISUMCL(I).EQ.0)GO TO 110
      T=THETA(IXI(I,ICAT),NI(I),A(ICAT),ASUM,NOCAT)
      B=B+(ISUMCL(I)/RTOT)*BIAS(T,NI(I),A(ICAT),ASUM,NOCAT)
      V=V+(ISUMCL(I)/RTOT)**2*VAR(T,NI(I),A(ICAT),ASUM,NOCAT)
110   CONTINUE
      CMSE=V+B**2
      FMSE=FMSE+ALPHA(ICAT)*CMSE
100   CONTINUE
      RETURN
      END
```

Appendix B.8


```
      SUBROUTINE FMSEC(FMSE,ALPHA,IXI,NI,A,ASUM,NOCAT,NOCLS,ISUMCL,
     1 RTOT)
C
C     THIS SUBROUTINE WILL CALCULATE THE MSE VALUE FOR THE
C      SEQUENTIAL BAYESIAN CLUSTER OPTION
C
      DIMENSION A(5),ALPHA(5),NI(30),IXI(30,5),ISUMCL(30)
      FMSE=0
      DO 100 ICAT=1,NOCAT
      CMSE=0
      DO 110 I=1,NOCLS
      IF(ISUMCL(I).EQ.0)GO TO 110
      T=THETA(IXI(I,ICAT),NI(I),A(ICAT),ASUM,NOCAT)
      CMSE=CMSE+(ISUMCL(I)/RTOT)**2*RMSE(T,IXI(I,ICAT),NI(I),A(ICAT),
     1 ASUM,NOCAT)
110    CONTINUE
      FMSE=FMSE+ALPHA(ICAT)*CMSE
100    CONTINUE
      RETURN
      END
```

Appendix B.9

FILE [illegible]


```
      SUBROUTINE DMSES(IFRST,ILST,ISUMCL,IXI,NI,ASUM,NOCAT,A,ALPHA,      DMS00010
     1 RTOT,DMSE)                                                        DMS00020
C     [illegible] DELTA MSE FUNCTION                                     DMS00030
C     [illegible]                                                        DMS00040
C                                                                        DMS00050
      DIMENSION ISUMCL(30),NI(30),IXI(30,5),A(5),ALPHA(5),DMSE(30)       DMS00060
      DO 100 I=IFRST,ILST                                                DMS00070
      DMSE(I)=0                                                          DMS00080
      IF(ISUMCL(I).EQ.0)GO TO 100                                        DMS00090
      DO 100 J=1,NOCAT                                                   DMS00100
      T1=THETA(IXI(I,J),NI(I),A(J),ASUM,NOCAT)                           DMS00110
      NI2=NI(I)+1                                                        DMS00120
      T2=THETA(IXI(I,J),NI2,A(J),ASUM,NOCAT)                             DMS00130
      IX2=IXI(I,J)+1                                                     DMS00140
      T3=THETA(IX2,NI2,A(J),ASUM,NOCAT)                                  DMS00150
      V1=(ISUMCL(I)/RTOT)**2*VAR(T1,NI(I),A(J),ASUM,NOCAT)               DMS00160
      B1=(ISUMCL(I)/RTOT)*BIAS(T1,NI(I),A(J),ASUM,NOCAT)                 DMS00170
      RMSE1=V1+B1**2                                                     DMS00180
      V2=(ISUMCL(I)/RTOT)**2*VAR(T2,NI2,A(J),ASUM,NOCAT)                 DMS00190
      B2=(ISUMCL(I)/RTOT)*BIAS(T2,NI2,A(J),ASUM,NOCAT)                   DMS00200
      RMSE2=V2+B2**2                                                     DMS00210
      V3=(ISUMCL(I)/RTOT)**2*VAR(T3,NI2,A(J),ASUM,NOCAT)                 DMS00220
      B3=(ISUMCL(I)/RTOT)*BIAS(T3,NI2,A(J),ASUM,NOCAT)                   DMS00230
      RMSE3=V3+B3**2                                                     DMS00240
      CMSE=(RMSE1-((1-T1)*RMSE2)-T1*RMSE3)                               DMS00250
      DMSE(I)=DMSE(I)+ALPHA(J)*CMSE                                      DMS00260
  100  CONTINUE                                                          DMS00270
      RETURN                                                             DMS00280
      END                                                                DMS00290
                                                                         DMS00300
```

Appendix B.10


```
      SUBROUTINE DMSEC(IFRST,ILST,ISUMCL,IXI,NI,ASUM,NOCAT,A,ALPHA,
     1 RTOT,DMSE)
C
C     THIS SUBROUTINE WILL CALCULATE THE DELTA MSE FUNCTION
C     FOR THE BAYESIAN CLUSTER OPTION
C
      DIMENSION ISUMCL(30),NI(30),IXI(30,5),A(5),ALPHA(5),DMSE(30)
      DO 100 I=IFRST,ILST
      DMSE(I)=0
      IF(ISUMCL(I).EQ.0)GO TO 100
      DO 100 J=1,NOCAT
      T1=THETA(IXI(I,J),NI(I),A(J),ASUM,NOCAT)
      NI2=NI(I)+1
      T2=THETA(IXI(I,J),NI2,A(J),ASUM,NOCAT)
      IX2=IXI(I,J)+1
      T3=THETA(IX2,NI2,A(J),ASUM,NOCAT)
      RMSE1=RMSE(T1,IXI(I,J),NI(I),A(J),ASUM,NOCAT)
      RMSE2=RMSE(T2,IXI(I,J),NI2,A(J),ASUM,NOCAT)
      RMSE3=RMSE(T3,IX2,NI2,A(J),ASUM,NOCAT)
      CMSE=(ISUMCL(I)/RTOT)**2*(RMSE1-((1-T1)*RMSE2)-T1*RMSE3)
      DMSE(I)=DMSE(I)+ALPHA(J)*CMSE
100   CONTINUE
      RETURN
      END
```

Appendix B.11

FILE: THETA   FORTRAN A   PURDUE / LARS 3031   PAGE 001

```
      FUNCTION THETA(IXI,NI,A,ASUM,NOCAT)                               THE00010
C                                                                       THE00020
C     THIS FUNCTION COMPUTES THE VALUE FOR THETA USED IN THE            THE00030
C      BAYESIAN PROPORTION ESTIMATOR CALCULATION                        THE00040
C                                                                       THE00050
      THETA=(IXI+A+1)/(NI+ASUM+NOCAT)                                   THE00060
      RETURN                                                            THE00070
      END                                                               THE00080
```


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OF POOR QUALITY

Appendix B.12

FILE: BIAS   FORTRAN A   PURDUE / LARS 3031

```
      FUNCTION BIAS(THETA,NI,A,ASUM,NOCAT)
C
C     THIS FUNCTION WILL COMPUTE THE BIAS FOR THE SEQUENTIAL
C      BAYESIAN ALLOCATION ESTIMATE
C
      BIAS=(A+1-THETA*(ASUM+NOCAT))/(NI+ASUM+NOCAT)
      RETURN
      END
```

Appendix B.13


```
      FUNCTION VAR(THETA,NI,A,ASUM,NOCAT)
C
C     THIS FUNCTION WILL COMPUTE THE VARIANCE FOR THE SEQUENTIAL
C      BAYESIAN ALLOCATION ESTIMATE
C
      VAR=(NI*THETA*(1-THETA))/((1+ASUM+NOCAT))**2
      RETURN
      END
```

Appendix B.14


```
      FUNCTION RMSE(THETA,IXI,NI,A,ASUM,NOCAT)
C
C     THIS FUNCTION COMPUTES THE MSE VALUE USE IN THE
C     BAYESIAN PROPORTION ESTIMATOR CALCULATION
C
      RMSE=((NI*THETA*(1-THETA))+(A+1-THETA*(ASUM+NOCAT))**2)/
     1 (NI+ASUM+NOCAT)**2
      RETURN
      END
```

Appendix B.15


```
*  THIS EXEC WILL RUN THE PROPORTION ESTIMATE PROCESSOR
&CONTROL OFF NOMSG
&IF &INDEX NE 2 &GOTO -MSG
GETDISK JSC770 191 370 C RR PASS AUCOIN
REMOTE E TO HOUSTON
SPOOL PRINTER NOHOLD COPY 1
&A = &SUBSTR &2 4
FILEDEF FT21F001 DISK PRP CC A (LRECL 80 BLOCK 80 PERM
FILEDEF FT20F001 DISK &1 DUMD (LRECL 80 BLOCK 80 RECFM F PERM
FILEDEF FT25F001 DISK &1 DUMM (LRECL 80 BLOCK 80 RECFM F PERM
FILEDEF FT22F001 DISK &1 EXEC (LRECL 80 BLOCK 80 PERM
FILEDEF FT06F001 PRINTER (RECFM FA
FILEDEF FT29F001 DISK &1 &2 (LRECL 80 BLOCK 80 PERM
FILEDEF FT24F001 DISK &1 PROC2 A1(RECL 80 BLOCK 80 RECFM F PERM
FILEDEF FT15F001 TERMINAL (PERM
FILEDEF FT07F001 TERMINAL (PERM
&STACK &A
GLOBAL TXTLIB FORTRAN CMSLIB
LOAD PRPEST BLKCOM (START CLEAR
&ERROR &EXIT
EXEC &1
&READ VARS &C
&READ VARS &D
&ERROR &CONTINUE
STATE &1 &C A
&IF &RETCODE NE 0 &GOTO -CHK2
ERASE &1 &C A
-CHK2 STATE &1 &D A
&IF &RETCODE NE 0 &GOTO -PROC
ERASE &1 &D A
-PROC RENAME &1 DUMD A &1 &C A
RENAME &1 DUMM A &1 &D A
ERASE &1 EXEC A
REL C (DET
&EXIT
-MSG &BEGTYPE
THE SYNTAX FOR THE PRP EXEC IS
      PRP SEGNUM PIAXXXX
      WHERE SEGNUM IS SEGMENT NUMBER
      AND LISTXXXX IS THE NAME OF THE LIST LABEL FILE TO USE
      NOTE: THE CONTROL CARD FILE MUST BE NAMED PRP CC
&END
```